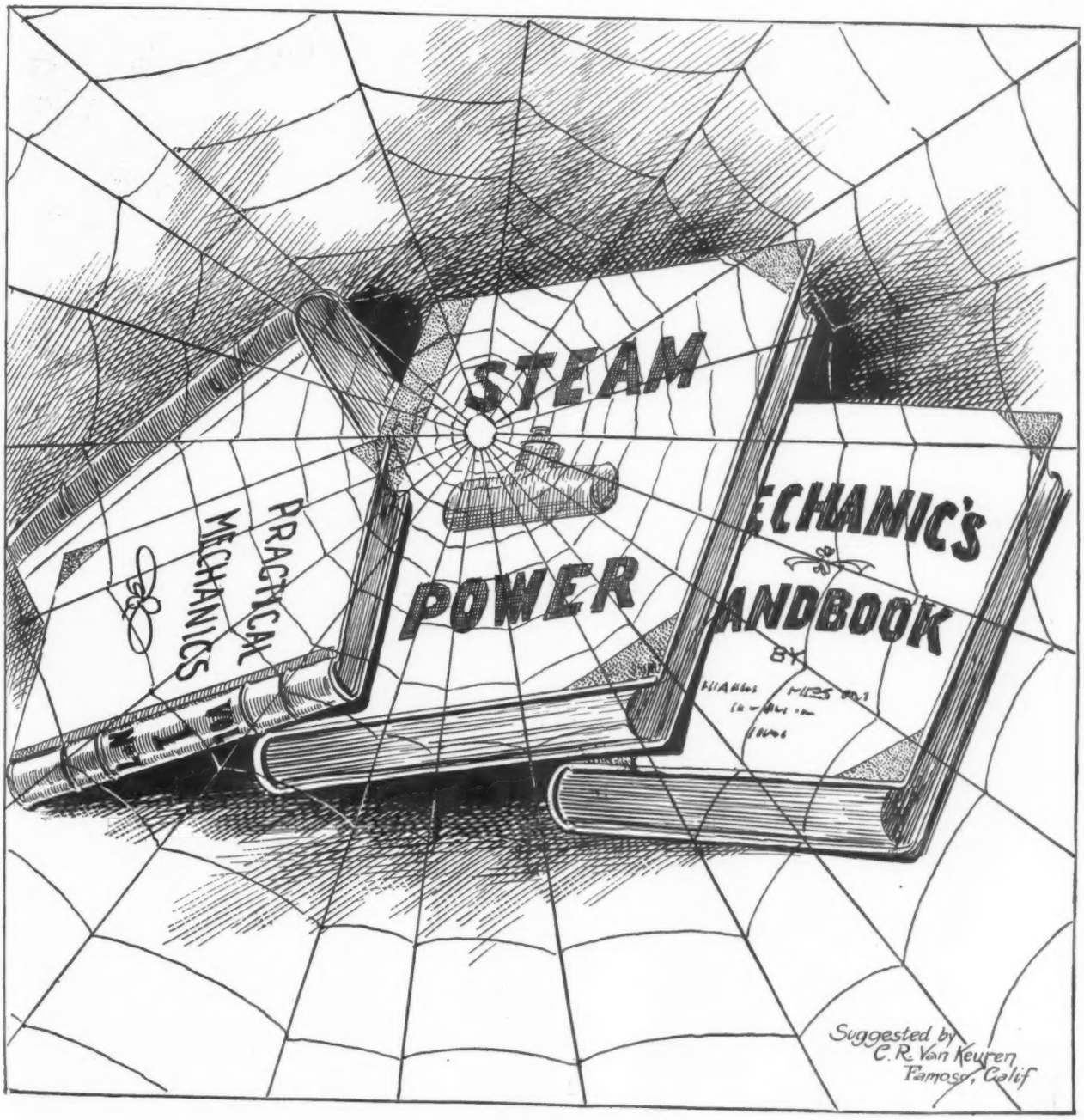
POWER

Vol. 40 NEW YORK, SEPTEMBER 29, 1914 No. 13



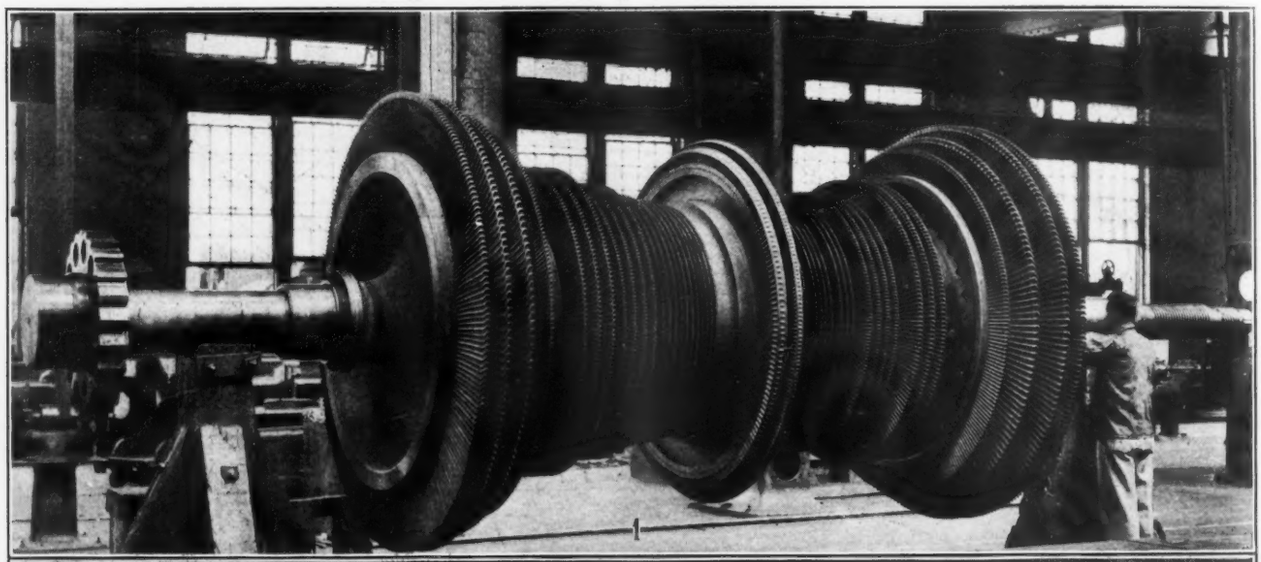
DID THIS HAPPEN DURING THE SUMMER?

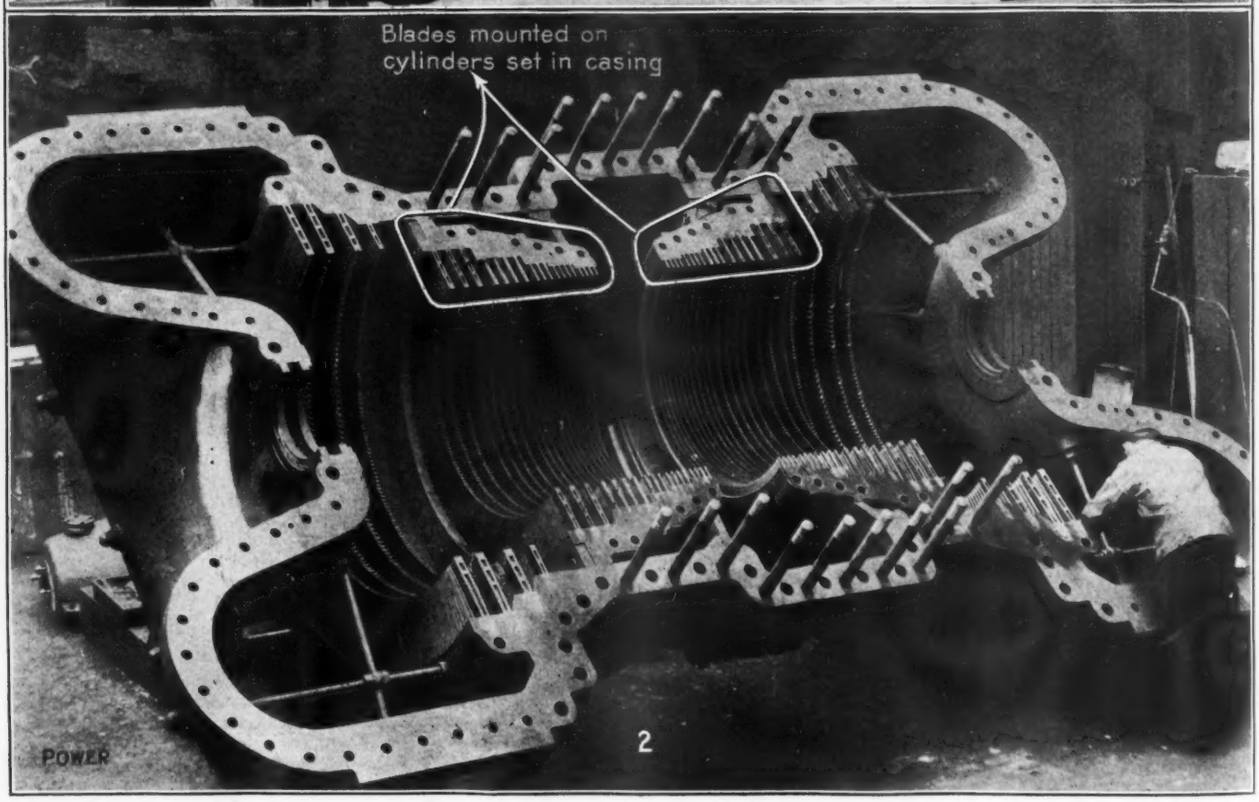
Brooklyn Edison Co's New Turbine

By Charles H. Bromley

SYNOPSIS—The new 22,000-kw. double-flow turbine for the Gold St. station of the Edison Electric Illuminating Co., of Brooklyn, is the largest single-cylinder machine yet built. It is in a space formerly reserved for a 5000-kw. turbo-generating set; the stationary blading is set into cylinders instead of being mounted directly on the casing; straight nickel is used for the high-pressure blading and nickel bronze for the intermediate and low-pressure; the condenser has 30,500 sq.ft. of 1½-in. tubes of admiralty composition; the tubing weighs 28 tons, and there is over 17 miles of it. The auxiliaries are guaranteed to consume not more than 4½ per cent. of the amount of steam consumed by the main unit. The intermediate pressure stages will receive the exhaust from the auxiliaries.

The Gold St. station of the Edison Electric Illuminating Co., where this new double-flow Westinghouse turbine has been installed, was originally designed for six 5000-kw. turbo-generating sets.





Figs. 1 and 2. The Rotor and Top Half of the 22,000-Kw. Double-Flow Turbine, the Largest Built with a Single Casing

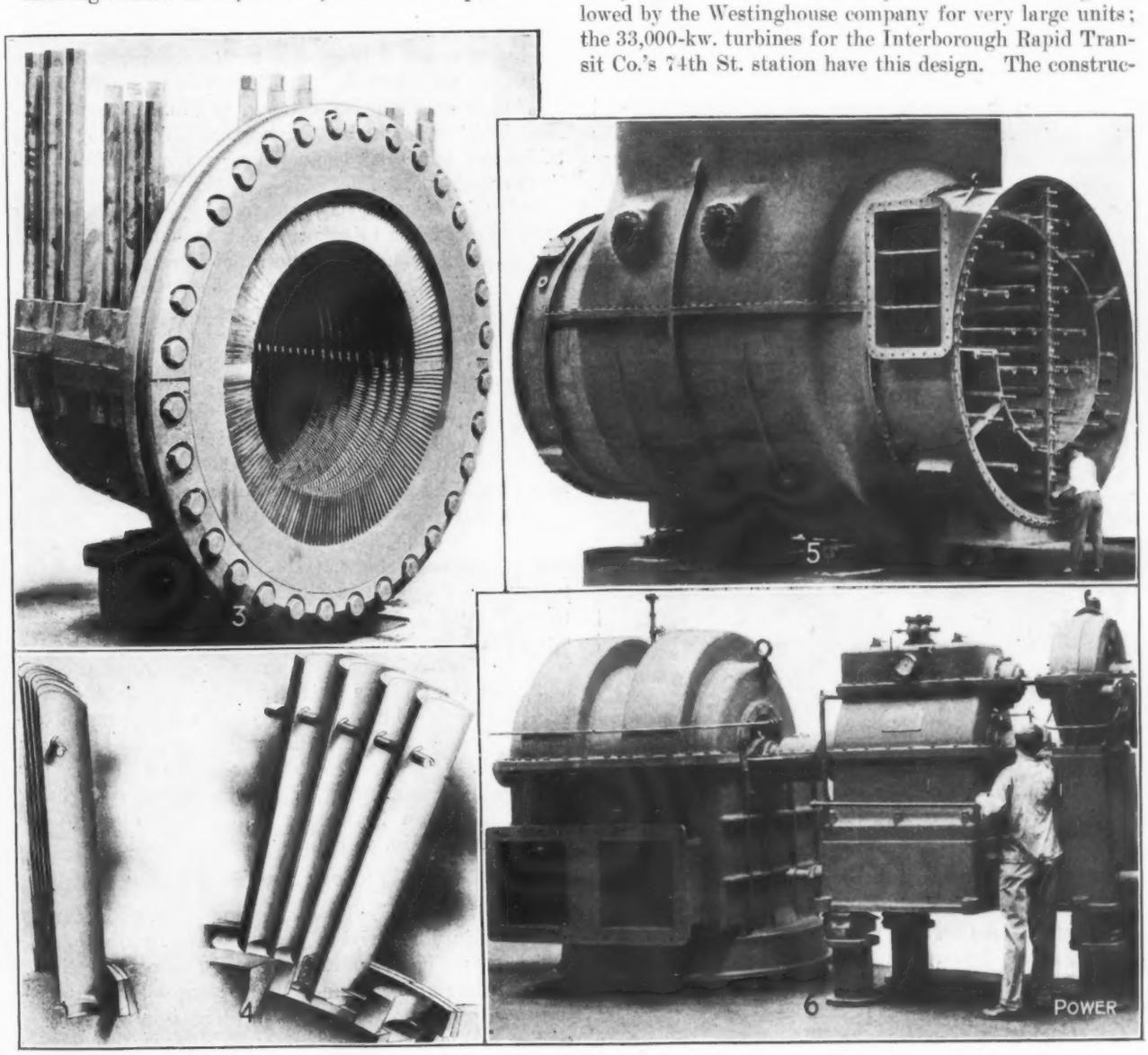
22,000 Kw. in Space for 5000 Kw.

It is noteworthy that the new turbine, of 22,000 kw. rated capacity, is situated on the floor space originally intended for a 5000-kw. machine; over four times the capacity per unit area of floor space. This is a most commendable achievement of turbine designers, considering the real estate values in places occupied by many stations requiring large capacities, although these values are seldom more than 12 per cent. of the cost of the unit. Fig. 1 shows the spindle with blades and Fig. 2 the casing cover.

Although rated at 22,000 kw., the set is expected to carry 25,000 kw. for a reasonably long time with a temperature rise of 50 deg. F. The complete set measures 44 ft. 6 in. in length, is 16 ft. 3 in. wide at the base and 12 ft. high. The total weight is 900,000 lb. (450 tons), and the heaviest piece to be lifted by the crane weighs 77,000 lb. At 25,000 kw., the weight per kilowatt is only 36 lb., and 30.43 kw. are accommodated on a square foot of floor space.

110,583,750 Cu.Ft. of Steam Passed per Hour

The turbine is of the double-flow type, having the usual two exhaust openings, with a total area of 90 sq. ft. At 28½-in. vacuum, equivalent to 0.735 lb. absolute pressure, steam has a volume of 444 cu.ft. per lb., and at the peak load, these exhaust openings will have to pass steam at the rate of 110,583,750 cu.ft. per hr., allowing for the quality after expansion only; the velocity through the openings will be 341.3 ft. per sec. The high- and intermediate-pressure stationary blading will not be fastened directly to the casing, but will be mounted on cylinders set into it. This practice is now being followed by the Westinghouse company for very large units; the 33,000-kw. turbines for the Interborough Rapid Transit Co.'s 74th St. station have this design. The construction gives the casing a more uniform diameter, thereby reducing stresses; it facilitates its manufacture, and it enables the blades and their mountings to be removed or replaced conveniently.



Blades and Some Auxiliaries for the Brooklyn Edison Co.'s New Turbine

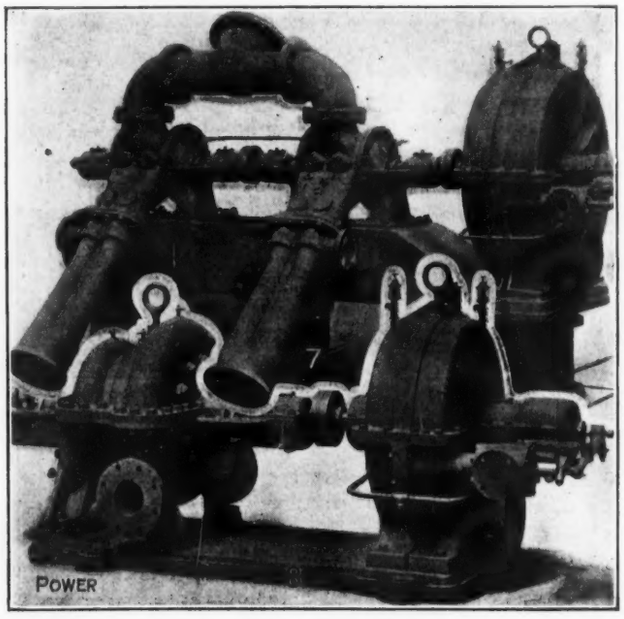
Fig. 3. Intermediate pressure blading.
Fig. 4. How the blading is mounted.
Fig. 5. Condenser; 35,000 sq.ft. of 1½-in. tubes.
Fig. 6. 30,000 gal. per min. circulating pump.

Straight-Nickel High-Pressure Blades

Straight-nickel blades will be used for the high-pressure stages, and nickel-bronze for the intermediate- and

low-pressure stages. The blades are of greater cross-section at the root or bottom than at the top. This construction tends to reduce, if not to eliminate, vibration; but as the blades are of greater cross-section at the bottom, the stresses to which a blade is subjected are distributed more evenly, so that the root does not bear the greatest stress, as in blades of the ordinary design. The root ends are forged and have about 40 per cent. greater area of cross-section than at the top.

Fig. 4 shows how the blades are assembled. At 22,000 kw., the guarantee calls for a steam rate of 12½ lb. per kw-hr. at 170 lb. pressure, 100 deg. F. superheat, 28½ in. vacuum and 1500 r.p.m. The lowest consumption is at about 17,000 kw. (68 per cent. of the maximum and 77.2 per cent. of the rated capacity), when the curve drops a trifle below 12 lb. per kw.-hr. The generator will furnish three-phase, 25-cycle current at 6600 volts, and has a guaranteed efficiency of 97 per cent., allowing for all losses due to windage, blowers, etc. The usual 2 per cent. speed variation, no load to full load, is allowed. The ordinary type of governor will not be employed,



FIGS. 7 AND 8. AIR AND HOT-WELL PUMPS

owing to the necessity for avoiding the possibility of trouble due to the governor sticking at times of sudden peaks, for the load on this machine will be constant for long periods.

THE GUARANTEED STEAM RATE

The steam consumption of the auxiliaries is quite low, being guaranteed to be but 4½ per cent. of that of the main unit. The exhaust from the auxiliaries will be admitted to the intermediate stages of the turbine, through a differential valve which may be set to cut in and out automatically when the load on the main unit varies within predetermined limits, the range depending upon the amount of exhaust steam needed in the feed-water heater to maintain the temperature of the feed.

For the rated capacity of 22,000 kw., the steam consumption is 12.5 lb. per kw.-hr. This means an hourly consumption of 275,000 lb. for the main unit, and, as the auxiliaries need 4.5 per cent. of this amount, or 12,375 lb. per hr., the total hourly consumption will be 287,375 lb. If the boilers are assumed to evaporate 9.5 lb. of water per lb. of coal, then the coal consumption for both the turbine and its auxiliaries is 15.125 tons per hr., or 363 tons every 24 hr. On this basis, 1.375 lb. will be necessary per kw.-hr., not including that required for the 100-hp. motor used for ventilating the generator.

CONDENSING EQUIPMENT

The unit will have a Westinghouse radial-flow condenser, Fig. 5, of 35,000 sq.ft. of tube surface, giving 1.59 sq.ft. of cooling surface per kilowatt. The lowest ratio, so far as the writer knows, is at the Waterside No. 2 station of the New York Edison Co., where a 25,000-sq.ft. condenser serves a 22,000-kw. turbine, giving 1.14 sq.ft. of surface per kilowatt. The condenser will have 45,000 1½-in. tubes, 20 ft. 3 in. long, of No. 16 gage. The shell is 16 ft. 4 in. in diameter and 27 ft. long. The tubing, of admiralty composition, weighs 28 tons, and there are about 17 miles of it

Tubes for this plant are bought on a guarantee for one year, replacements being made by the manufacturers for those becoming defective within that time. The Gold St. station is immediately alongside the outlet of a 17-ft. sewer and the condensing water is severe on condenser tubes. Tubes of this size are unusual, but as a smaller condenser with 1½-in tubes in the 66th St. station of the Brooklyn Edison Co. has given four years' service without having a cent spent on it except for cleaning, it was deemed best to use the same size tubes for the new unit; then, too, it is a question whether a year's guarantee would be given with 1-in. tubes.

Two 30,000-gal. per min. Westinghouse turbine-driven centrifugal pumps, Fig. 6, driven through Westinghouse-Melville reduction gear, ratio 10 to 1, will furnish the cooling water. Each turbine is of 235 hp. and will run at 2500 r.p.m., giving the pump a speed of 250. The circulating water-pumping capacity per hour per kilowatt rated capacity is 163 gal. For the rated capacity of 22,000 kw. and the guaranteed steam consumption of 12.5 lb. per kw.-hr., the circulating water-pumping capacity gives 108.7 lb. of cooling water per pound of steam condensed. It is expected that during the winter but one pump will be run, owing to the circulating water being cold. The main circulating water discharge into the condenser is 36 in. in diameter and the outlet is 48 in.

THE AUXILIARY POWER

A Westinghouse-LeBlanc air pump, Fig. 7, driven by an 85-hp. turbine and two two-stage wet vacuum or hot-well pumps, Fig. 8, each having a 70-hp. turbine, will be used. These pumps were built to pump against 100 lb. pressure, owing to pipe friction. The total horsepower of the auxiliary turbines is 695, therefore with an overall efficiency of 90 per cent. for the turbine and generator, the ratio of main-unit to auxiliary power is 38 to 1, figured on the normal rating of 22,000 kw. As the water velocity through the tubes will be low, the bell ferrule will not be employed, as but little erosion of the ferrules is expected.

With cooling water at 60 deg. F., a vacuum of 28.9 in. is guaranteed, and 28.6 in. for 70-deg. water.

COOLED AND MOISTENED AIR FOR THE GENERATOR

In large power-plant practice especially, much attention is being given to the ventilation of generators, for

the time which the set will carry maximum capacity is limited chiefly by the temperature rise in the generator.

The Brooklyn machine will be ventilated by moistened and cooled air. Briefly, the plan is to maintain a pool of water in the bottom of the fan casing, the distance between the fan and the water being such that when the fan is in motion, enough water will be picked up to moisten and cool the air. As the air enters the delivery side of the duct, it passes between a number of corrugated copper plates which take out entrained water. It is expected that the set will be able to carry from 12 to 15 per cent. more load when fitted with this ventilator than if it had the usual equipment.

Station designers would do well to take advantage of this principle of generator ventilation, for in new plants the heated air leaving the generators might just as well be supplied to the boiler furnaces, and by a suitable arrangement of ducts, heated air from over the boilers might easily be induced into branch ducts joining the main duct, thus increasing the boiler economy, besides cooling the generator at little additional initial investment.

Legal Rights Concerning Dams

By A. L. H. Street

SYNOPSIS—Authority to maintain structure may be acquired by legislative or private grant, or by long continued enjoyment. Application to public authorities often required by statute, notwithstanding private conveyance of right. Obligations of proprietor to upper and lower riparian land owners. Privileges which may and which may not be exercised. Remedies against improper maintenance.

The maintenance of dams for power purposes has afforded the basis of much litigation, as is evidenced by the reports of the state and federal appellate courts, with a result that the legal principles applicable to such structures have become fairly well settled. To give the readers of POWER a general view of the most important of these principles, so far as they may prove to be of practical interest, the writer has prepared the following summary of the law on this subject, as announced by the highest courts of the country. Citations showing where the full text of some of the leading decisions can be found are given, though the list of citations does not purport to be exhaustive. The observations here made are limited to questions bearing on the right to occupy the channel of a stream with a dam, to detain water from lower riparian owners, and to flow the lands of upper proprietors, leaving out of consideration questions relating to the right to appropriate the waters of a stream—a subject which the writer hopes to be able to cover in a later article in POWER.

How Right May Be Acquired

The legal right to erect and maintain a dam may be acquired in any one of the following ways: (1) By virtue of ownership of the land on which it is constructed, (2) by grant from public authorities, (3) by deed from private land owners, and (4) by long assertion of right.

1. In the absence of statutory provision to the contrary, an owner of land along a non-navigable stream is entitled to erect a dam on his own land, without regard to upper and lower riparian owners, if he does not prejudice the lower owners by appreciably diminishing the quantity of water which would naturally flow through their lands, and subject to liability to upper owners for overflowing their lands (California Supreme Court, 69 Pacific Reporter 618; Texas Court of Civil Appeals, 40 Southwestern Reporter 1031). As held by the Massachusetts Supreme Judicial Court, the right to create water power by damming a stream is inseparably connected with ownership of the land through which it flows and does not depend upon acquisition by deed or prescription of rights in land abutting the stream below the dam (88 Northeastern Reporter 332). But in Kentucky it has been held by the Court of Appeals that no one can lawfully erect a dam in a watercourse without first obtaining leave from the court in the manner prescribed by statute (5 Southwestern Reporter 49). And in several other states there are in force laws commonly known as the Mill Dam Acts which require one who desires to erect a dam to apply to public authorities for permission, which is to be granted or withheld on consideration of the public health, as well as the rights of upper and lower riparian owners. Provision is usually made in these laws for the assessment and collection of damages to private property caused by the construction of the dam. Similar procedure is prescribed to acquire the right to increase the height of an existing dam. The statutes of Missouri entitle one who is injured by the construction of a dam, without permission having been first obtained from the county court, to recover double the amount of his damages, and it is likely that similar provisions are in force in other states.

2. The legislature of a state has power to authorize the construction of a dam across a non-navigable stream (United States Supreme Court, 26 Supreme Court Reporter 127; 123 Federal Reporter 707). As a general rule, statutory permission is necessary to authorize the erection of a dam across a navigable river, although it has been held that a riparian owner is entitled to place a dam in the stream if the character of navigation is not such that the dam will constitute a substantial interference (Minnesota Supreme Court, 77 Northwestern Reporter 41; Oregon Supreme Court, 60 Pacific Reporter 384). So far as Congress has not legislated upon the subject, a state may authorize the construction of a dam across a navigable river lying wholly within the limits of the state, for the improvement of navigation, or any other public purpose (United States Supreme Court, 2 Peters 245; 95 United States Reports 459). Legislative permission to construct a dam does not, however, exempt the owner from liability for resulting injury to the private property of others (57 Maine Supreme Judicial Court Report 181; 44 New Hampshire Supreme Court Reports 105). Under United States Revised Statutes, sections 2339, 2340, acquisition of right by prior occupancy to

maintain a dam on public lands has been frequently recognized by the courts.

3. Right to maintain a dam on another's land constitutes such interest in the land that it can be conveyed only by deed or by reservation in a deed (New York Supreme Court, 58 New York Supplement 239; North Carolina Supreme Court, 20 Southeastern Reporter 725). Grant of such privilege is irrevocable by the grantor and operates to relinquish any claim by him on account of damage resulting to his remaining land in the proper exercise of the right (21 Massachusetts Supreme Judicial Court Reports 365). The fact that a dam owner has maintained a 7-ft. head of water only for many years does not prevent him from afterward maintaining an 8-ft. head as against one who granted the right to maintain the greater head. Grant of right to maintain a *head* of water at a certain height does not authorize maintenance of a *dam* at that height, if water flows over the crest at a depth of two or more inches (Michigan Supreme Court, 138 Northwestern Reporter 1073).

4. Maintenance of a dam in a particular manner for many years confers a prescriptive right upon the owner to continue it (116 Illinois Appellate Court Reports 1). A "prescriptive right" is one which the possessor acquires by reason of its continued enjoyment for so long a time as to render it inequitable to deny its existence. But it has been decided by the courts that, by maintaining a dam for 20 years, the owner did not acquire such right as precluded the state from compelling the erection of fishways; and, as decided by the Illinois Supreme Court, a prescriptive right to flood the lands of an upper riparian owner can arise only where the land has been flooded for a period of 20 years or more, and where the flowing was adverse and uninterrupted and took place with the knowledge and acquiesence of the land owner affected (78 Northeastern Reporter 42). This rule is probably applicable in all the states, subject to different holdings as to the length of time the adverse use must continue. The right has been held to be subject to acquisition in Michigan on 15 years' use. But in a recent New York case it was held that judgment in favor of a land owner for six cents damages through maintenance of a dam which flooded his land prevented the power company which maintained the structure from obtaining any prescriptive right of flowage (New York Supreme Court, 136 New York Supplement 383). And it was lately decided that a company which obtained a prescriptive right to maintain a power dam could be enjoined by upper land owners from raising the dam to their injury, although denial of permission to increase the height results in disproportionate injury to the company (Michigan Supreme Court, 141 Northwestern Reporter 693). But the fact that water is set back upon upper land by mere repair of a dam so as to make it tight does not give the upper owners a cause of action, if the dam is no higher than that which the owner has been granted the right to maintain (Illinois Supreme Court, 87 Northeastern Reporter 962). If a dam is so constructed and maintained as to constitute a public nuisance, right to continue its maintenance cannot be acquired by prescription. But when a right has been once obtained by prescription, it will be as fully protected by the courts as though it had been expressly granted by the persons against whom it is asserted (4 New Jersey Equity Reports 116). An owner of land, who by lapse of time has lost the right to object to a dam used in the operation of a mill, cannot enjoin its continuation to provide power for an electric-light plant, unless the change operates to his prejudice by a greater obstruction of the flow of the stream (Kansas Supreme Court, 102 Pacific Reporter 783). But where the right to flood land is acquired by adverse user the owner of the land acquires a reciprocal right to have the water maintained at the same ordinary height (Texas Court of Civil Appeals, 138 Southwestern Reporter 150; Vermont Supreme Court, 77 Atlantic Reporter 866). These principles applicable to the maintenance of dams proper are equally applicable to the maintenance of flashboards (Massachusetts Supreme Judicial Court, 58 Northeastern Reporter 181).

Although the owner of a dam is entitled to detain the waters of the stream so far as is reasonable in his proper use of them, he is not entitled to divert water or to unnecessarily cause loss thereof to lower owners by absorption or evaporation (United States Supreme Court, 4 Mason 397; 1 Hun (N. Y.) 272). When the height at which a dam is permitted to be constructed is determined with reference to "low-water mark," the height of the water at ordinary stages of low water, and not at the lowest stage in seasons of great drouth, governs (Kentucky Court of Appeals, 65 Southwestern Reporter 156).

Right to maintain a dam may be lost by a showing of clear intention to abandon the privilege, but the mere fact that the dam is permitted to decay and remain unrepaired for several years does not establish abandonment of right to renew the structure, in the absence of other evidence of intent to abandon the right (New York Supreme Court, 77 New York Supplement 282). There are earlier cases in other states, however, holding that license to maintain a dam expires with its decay (24 New Hampshire Supreme Court Reports 364; Pennsylvania Supreme Court, 17 American Decisions 677). Right to flood land by water from a dam is not extinguished by a change in the dam's location, if the area flooded is not thereby increased (Rhode Island Supreme Court, 41 Atlantic Reporter 564).

Maintenance of a dam in an unauthorized manner may be enjoined and damages awarded to cover injury already done. A dam maintained in a navigable stream in violation of law constitutes a public nuisance which may be abated on suit (72 Maine Supreme Judicial Court Reports 181); and the owner may be held liable for injury resulting therefrom to private property owners. But all damages claimed by a permanent overflow must be recovered in one suit; where a dam causes occasional recurrent overflows, each overflow affords a separate cause of action in favor of an injured land owner. The damages recoverable for permanent injury to land are measurable by the reasonable value of the land permanently overflowed and the diminished value of the remainder of the tract. If the injury is not permanent, the measure of recovery is the reasonable cost of restoring the premises, plus the difference in their rental value with and without the overflow during the continuance thereof (Alabama Supreme Court, 61 Southern Reporter 934).

The Production of Coal in Iowa in 1913 was 7,490,641 short tons, valued at $13,431,061, according to figures compiled by E. W. Parker, of the United States Geological Survey, in cooperation with the Iowa Geological Survey. This was an increase over 1912 of 201,112 tons in quantity, and of $278,973 in value.

Inexpensive Flue-Gas Analyzing Outfit

By G. M. Kohler

SYNOPSIS—Directions for the use and manipulation of an outfit which can be bought for less than $5. An analysis can be made in less than five minutes with fairly accurate results.

In recent issues of Power, considerable space has been allotted to the descriptions of apparatus and methods for analyzing flue gases. All of the outfits mentioned cost more than $25. Many engineers, especially those in charge of small plants and young men just starting in the profession, cannot afford to purchase such costly instruments. The entire outfit described below can be bought for less than $5, it will give fairly accurate analyses and will be helpful to the engineer who desires to learn more about combustion of fuels and efficient boiler operation.

The principal part of the apparatus is the glass tube *H*, in Fig. 1, known to chemists as a "Bunte" gas burette. It is about 1 in. in diameter and 20 in. long. The upper end has a funnel *F*, connected to the main part of the tube by the special three-way cock *C*. The lower end of the tube has a plain stop-cock *D*. The volume of the burette between the stop-cock *D* and the three-way cock *C* is about 115 c.c. A volume of 100 c.c. below stop-cock *C* is graduated to read in ½ c.c., which is ½ of 1 per cent. of the total volume above the zero mark. For convenience in manipulation the burette is attached, by means of the clamps *A*, to the iron stand *S*. A small vacuum pump or aspirator, made of standard pipe fittings, as shown in Fig. 2, is used to draw the flue gases from the furnace or flue to the burette. The gas to be analyzed can also be placed in the burette by means of a pair of bottles, as recently described in Power for the "Orsat."

In addition to the apparatus shown, there will be needed to make an analysis of flue gases, the proper absorbing liquids, viz.; a solution of potassium hydroxide for the absorption of CO_2, an acid solution of cuprous chloride for CO and a mixture of pyrogallic and potassium hydroxide for the absorption of oxygen. Directions for the preparation of these solutions have been given in recent issues of Power.

To fill the burette with a sample of the flue gases to be analyzed, connect the end *E* of the three-way cock *C*, by means of a rubber tube of about $\frac{3}{16}$ in. inside diameter, to the end of a ⅛- or ¼-in. pipe leading to the boiler setting of the furnace from which the gas is to be taken. Connect the nozzle *N* of the burette to the rubber tube *B*, Fig. 2. Now by properly adjusting cocks *C* and *D*, there will be a direct communication from the aspirator to the flue gases within the furnace, so that when water is allowed to flow through the aspirator, the flue gases will be drawn into the burette. The funnel *F* should be filled with water up to the 25-c.c. mark and must be at this level when all readings are made. The gas should be drawn through the burette until all the air in the pipes has been expelled and a fair sample of gas obtained; then shut cocks *C* and *D*, remove the tubes from *N* and *E* and place a cork or piece of tubing with one end closed over *E* to prevent water leaking out of funnel *F*.

In the burette, there is now about 115 c.c. of gas under a slight vacuum. To simplify the analysis the volume of gas in the burette is reduced to 100 c.c. by forcing water into the burette up to and a little above the zero mark. To do this the tube *A*, of Fig. 2, is connected to the nozzle *N* and water is allowed to enter the burette. Great care must be exercised in order that no air enter the burette. The water must be flowing from the tube *A* before it is slipped over the nozzle *N* and the cock *D* must not be opened until the tube is attached. When the tube is removed the water in the burette can be drained off to the zero mark by cautiously opening cock *D*, after which cock *C* should be opened gently, so as to allow sufficient gas to escape through the water in funnel

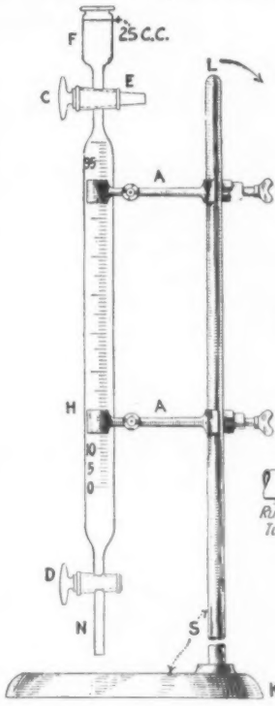


Fig. 1. Bunte Gas Burette

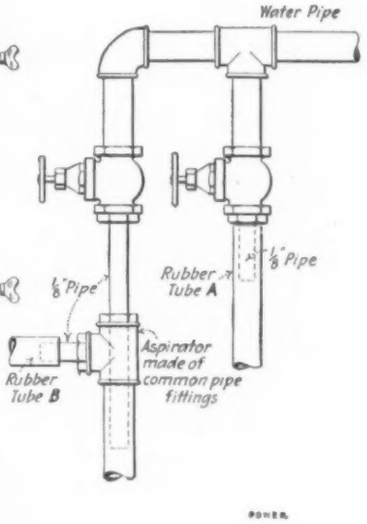


Fig. 2. Aspirator Made of Common Pipe Fittings

F, to reduce the pressure in the burette to that of the atmosphere plus that due to the column of water in the funnel *F*.

The burette now contains 100 c.c. of flue gas, composed of a mixture of nitrogen (N), carbon dioxide (CO_2), carbon monoxide (C) and oxygen (O). In order to ascertain the volume of each of these separate gases, it is necessary to place within the burette some liquid which will absorb one of the gases present. For the absorption of CO_2, a solution of potassium hydroxide is used. The tube *B* is connected to *N*, and water allowed to flow through the aspirator, thus producing a slight vacuum in the tube *B*, so that by opening cock *D* the water in the burette can be lowered until it just covers the cock. The cock should then be closed and the rubber tube removed. A slight vacuum now exists in the burette and by placing a cup containing the absorbing solution, so that the end

N of the burette is dipped under the surface of the liquid, and opening cock D, the absorbing liquid will rise in the burette to almost the zero point, after which cock D is closed.

To bring the gas in contact with the absorbing liquid, and hasten the analysis, the stand and burette can be swayed back and forth about the edge K in the direction of the arrow, by placing one hand at L. After doing this a dozen times the cup containing the absorbing liquid is again held under the end of the burette and cock D opened. If no liquid enters the tube the absorption is complete.

See that funnel F is now filled with water to the 25-c.c. mark, and open cock C so that water can flow into the burette, at the same time adding sufficient water to maintain the proper level in F. When no more water will enter the burette, close the cock.

Now the volume of liquid contained in the burette above the zero mark can be read off and it will be equal to the volume of CO_2 gas contained in the original sample of 100 c.c., or in other words it will be the percentage by volume of the CO_2 present in the flue gas.

To continue the analysis and find the amount of CO present, first wash out the burette by opening cocks D and C, so as to allow water to flow through it, taking care that there is always water above both of these cocks to prevent loss of gas. When a pint or so of water has been passed through the burette, cocks D and C are closed. The water in the burette should stand at the same level as the absorbing liquid did when the reading for the percentage of CO_2 was taken. From this point on the method of analysis for CO is the same as described above for CO_2. The aspirator is used to form a vacuum in the burette and then a cup containing a solution of cuprous chloride is placed under the nozzle N and cock D opened, whereupon the liquid is drawn from the cup into the burette. The apparatus is swayed back and forth several times and more solution put in the burette, after which cock C is opened for a second or two to allow sufficient water to enter the burette to overcome any slight vacuum existing therein. The height of the liquid can then be read off, which, after deducting the former reading for the CO_2, gives the percentage of CO contained in the original sample of flue gas.

To analyze for oxygen the same method of procedure as described for CO is to be followed with the exception of the difference in the absorbing solution to be used.

The description of the method for analyzing flue gases with the above instrument, requires more time than the actual analysis itself. It is an easy matter to make a complete analysis in less than five minutes. The operation is simple when once understood and the outfit will give satisfaction in the hands of anyone who will handle it with reasonable care.

Motors, Their Principles and Uses--II

By Gordon Fox

SYNOPSIS—Direct-current motors are discussed as to their principles of operation, their classification, characteristics and speed control.

The frame of a direct-current motor consists essentially of a stationary outer magnetic ring or yoke to which is attached two or more polepieces projecting radially inward. The yoke is commonly made of cast iron or cast steel and the polepieces are bolted to or cast into its inner circumference. Around the polepieces are wound the magnetizing coils of copper wire, and upon the shaft is mounted a cylinder composed ordinarily of sheet-steel punchings. These are punched out in such a way as to present on the surface of the cylinder a series of slots parallel with the shaft; in these slots are arranged the armature coils, the whole rotating element being called the armature. The ends of the coils are connected to the commutator mounted in front of the drum on the shaft and rotating with it. Brushes bear upon the commutator and to these the armature terminals of the motor are connected. The action of the current in the armature conductors upon the magnetic field through the drum results in a turning effort which rotates the drum.*

The action of a direct-current motor is as follows: The armature is subjected to approximately the full line voltage, as its terminals are commonly connected to the two line wires when in operation. The electrical resistance of the armature circuit is small. Current passing through the armature conductors reacts upon the field magnetism to set the armature into rotation. As soon as the armature begins to rotate, its conductors begin to cut the magnetic lines of force emanating from the field poles, and this action, following the laws of the electric generator, sets up in the armature conductors an electromotive force in opposition to the voltage of the external circuit. As the motor increases its speed, this counter electromotive force increases in value, but it cannot quite equal the impressed voltage. The motor attains such a speed that the counter voltage is less than the impressed by an amount such that the voltage difference is just sufficient to force through the resistance of the armature circuit a current sufficient to react upon the field magnetism and produce a torque equal to the mechanical couple demanded by the external load. If the load increases the motor decreases its speed slightly, the counter electromotive force decreases and the voltage difference increases. An increased current is thus forced through the armature, producing sufficient torque to carry the increased load. The characteristic performance of all types of direct-current motors can most readily be understood if these facts are constantly borne in mind.

It will be seen that the speed of a motor depends upon the relation of the impressed voltage to the counter voltage. The latter is proportional to the number of conductors connected in series in the armature and the intensity of the field magnetism. If two armatures were

*See Part 1, page 420, Sept. 22 issue.

operated in the same field frame, one built with twice as many turns in series as the other, then the first would rotate at half the speed of the second. If a motor be operated at a given speed with the field magnetism at a given intensity and the intensity be decreased, then the motor will increase its speed. This is evident for it will be necessary for the armature conductors to pass the poles more rapidly in order to cut the same number of magnetic lines in a given time and maintain approximately the same counter voltage. The various speed characteristics obtained with direct-current motors all depend fundamentally upon the relations of speed to counter voltage and counter voltage to field magnetism.

Direct-current motors are ordinarily classified as being shunt wound, series wound or compound wound. This classification is based upon the method of connecting the field-magnet coils. It will be remembered that the speed and torque characteristics are directly dependent upon the field intensity. If this intensity is made to vary in different ways the characteristics of the motor are controlled in a corresponding degree. The three types of direct-current motor will be considered separately.

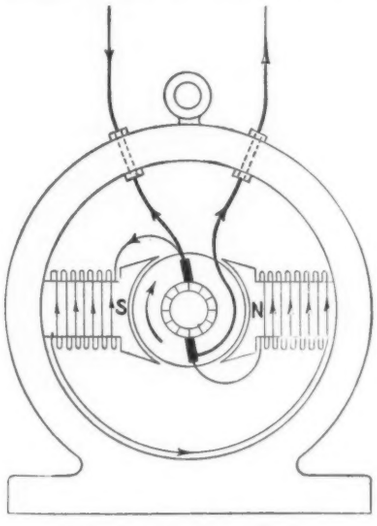


FIG. 1. SHUNT MOTOR

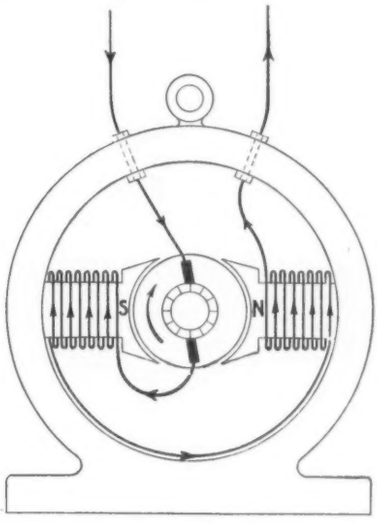


FIG. 2. SERIES MOTOR

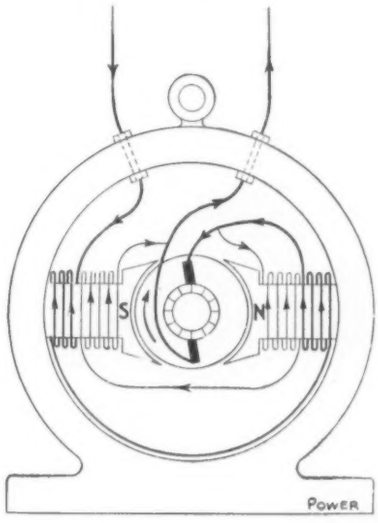


FIG. 3. COMPOUND-WOUND MOTOR

SHUNT-WOUND MOTORS

In a simple shunt-wound motor the terminals of the field circuit are connected directly across the line. The field is thus subjected to the full line voltage and the field intensity will remain approximately constant regardless of the load upon the machine and the current in the armature. This motor, then, is essentially a constant-speed machine, although actually the speed does decrease from three to five per cent. from no load to full load. The speed is also affected by the temperature of the field coils and is higher when they are hot, due to the increased resistance of the coils which reduces the field current. The speed can be changed slightly by shifting the brush position on the commutator, but the commutation is affected if the brushes are not correctly located. Fig. 1 shows diagrammatically the connections of a simple two-pole shunt-wound motor, and Fig. 4 gives the characteristics of a typical shunt-wound motor. It will be noted that the speed decreases slightly with an increase in load, that the efficiency is high over a considerable range of load, and that the torque is almost directly proportional to the armature current.

It is consistent with practically all electrical machinery that the larger units show slightly better performance than the smaller ones. For instance, a 5-hp. motor has a full-load efficiency of about 85 per cent., whereas a 100-hp. motor will, at full load, have an efficiency of 90 per cent. or higher. As a general rule, motors show their best efficiency when fully loaded. For instance, a 5-hp. motor, carrying a 5-hp. load, has an efficiency of 85 per cent., whereas a 10-hp. motor carrying a 5-hp. load has an efficiency of about 83 per cent. The efficiency of direct-current motors is independent of the speed. that is, a 10-hp. motor at 1800 r.p.m. and one at 600 r.p.m. will ordinarily have about the same efficiencies.

There are two features which limit the load any direct-current motor will carry; these are commutation and heating. When heavily overloaded a motor will spark at the brushes and roughening of the commutator will result. Due to inevitable losses in a motor heat is generated and the temperature of the working parts will rise. Excessive temperatures, ordinarily over 90 deg. C., are detrimental to the insulation of the coils. Standard horsepower ratings are based upon a rise of 40 deg. C. above the surrounding air. It is evident that increased load involves increased losses. It will carry overloads for short periods, the duration varying inversely with the amount of overload. A good motor will carry 100 per cent. overload momentarily without injurious sparking.

The shunt-wound motor finds a wide field of application in industrial service, since a large and varied class of machines require constant-speed motors with characteristics such as are possessed by the shunt motor. This motor is also commonly used for group and line-shaft drives.

SERIES MOTOR

The series motor, as its name implies, has its field circuit connected in series with the armature, as shown in Fig. 2. The wire in the field coils is necessarily large in order to carry the total load current, whereas in the shunt-wound motor the field coils are made up of a large number of turns of small wire carrying a current perhaps one-fiftieth of the value of the armature current. The characteristics of the series motor differ radically from those of the shunt motor. The field being con-

nected in series with the armature, its strength is proportional to the load on the motor. Thus, as load is added the field current increases and the field magnetism grows more intense; this acts to reduce the rotative speed. The series motor runs very slowly under heavy loads and the speed increases rapidly as the load is decreased. If the

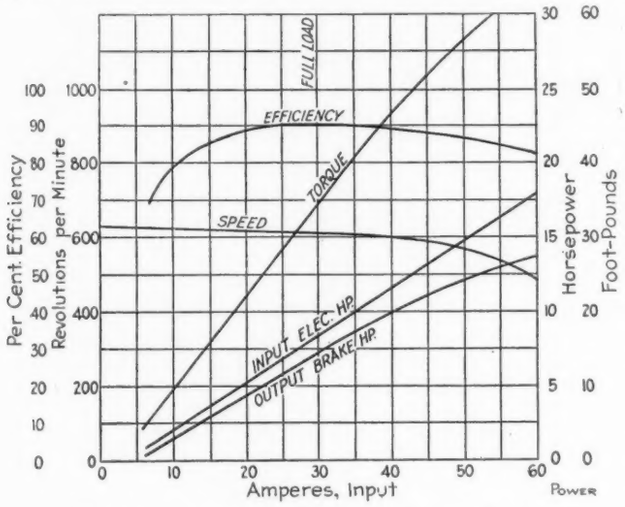


FIG. 4. CHARACTERISTICS OF SHUNT MOTOR

load be entirely removed, the current is so small that the field magnetism is almost nil and the armature must rotate at an enormous speed to maintain its counter electromotive force. Therefore, series motors are said to "run away" on no load and they are seldom used where it is possible for the load to be entirely removed.

An increase in current in a series motor not only increases the torque directly, but also by strengthening the field magnetism; therefore, the torque of this motor is extremely high under heavy loads where the heavy current operates the iron far above the saturation point. The standstill torque of a series motor may be several times the full-load torque. Fig. 5 illustrates the characteristics of a typical series motor designed for crane and hoisting service.

The efficiencies of series motors depend largely upon the ratings, which, in turn, are based upon temperature rises, but as they are commonly used for intermittent service the ratings ordinarily specify rises of from 40 to 55 or even 70 deg. C. for short periods of full-load operation. In intermittent service it is figured that during the periods of rest much of the heat generated during periods of action will be radiated. The rating used depends largely upon the percentage of the time that the motors are in use.

Series motors are used almost exclusively in traction service and for cranes, hoists, winches, presses and many classes of service where heavy torques at low speeds and excessive starting torques are required. Although in most cases the service is intermittent, they find many applications for continuous service.

COMPOUND-WOUND MOTORS

Compound-wound motors are a combination of the series- and the shunt-wound types, there being two entirely separate sets of coils upon the field poles. One set consisting of many turns of fine wire is connected across the line as in a shunt motor. The other set, consisting of a few turns of coarse wire, is connected in series with the armature. If the shunt and series coils act in the same direction, the motor is said to be cumulatively compound wound; if they act in opposition, it is differentially compound wound. Fig. 3 illustrates diagrammatically the connections of a cumulatively compound-wound motor.

The magnetizing effect of a coil of wire is measured by the number of ampere-turns, that is, the product of the current in amperes by the number of complete turns of wire. Thus the shunt coil having a small current flowing through a large number of turns may have a magnetizing effect comparable with the series coil, which has a heavy current flowing through a few turns. The ratio of series to shunt ampere-turns may, of course, be varied between any limits. Some motors are built with only about 10 per cent. shunt ampere-turns to prevent the motor from running too fast on light loads; others are built with as low as 5 per cent. series ampere-turns. Ordinarily about 20 per cent. of the ampere-turns at full load are in the series coils and the motors are said to have 20 per cent. compounding.

The characteristics of compound-wound motors combine in varying degrees the features of shunt and series motors. Thus cumulatively compound-wound motors, which are much the more common type, have speeds which decrease with an increase of load and torques which increase rapidly with an increase of load. Fig. 6 illustrates the characteristics of a typical 20 per cent. compounded motor.

In a differentially compound-wound motor the field intensity is weakened as the load increases, since the series coils are in opposition to the shunt coils. Thus the speed increases with an addition of load. In some cases this gain in speed will increase the load, which in turn will again raise the speed until a point is reached, such

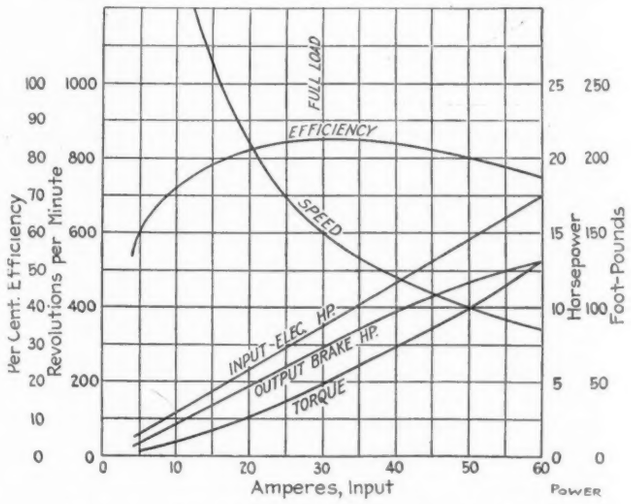


FIG. 5. CHARACTERISTICS OF SERIES MOTOR

that the series turns predominate over the shunt turns. The motor will then suddenly stop and reverse rotation. Due to its unstable and undesirable characteristics, this type is little used.

Compound-wound motors are used largely for elevator service where a heavy starting torque and a fairly constant running speed are required. They also find many industrial applications for pumps, compressors, shears, reciprocating machine tools, etc., where irregular loads with severe peaks are encountered together with a demand for fairly constant rotative speeds. Furthermore,

the compound motor is well adapted for use on circuits subject to voltage fluctuations, such as trolley circuits. This is because an increase in voltage tends to increase the speed to enable the counter voltage to increase. An increase in speed is attended by an increase in load. The series turns of the field therefore increase their effort and strengthen the magnetism. This helps to increase

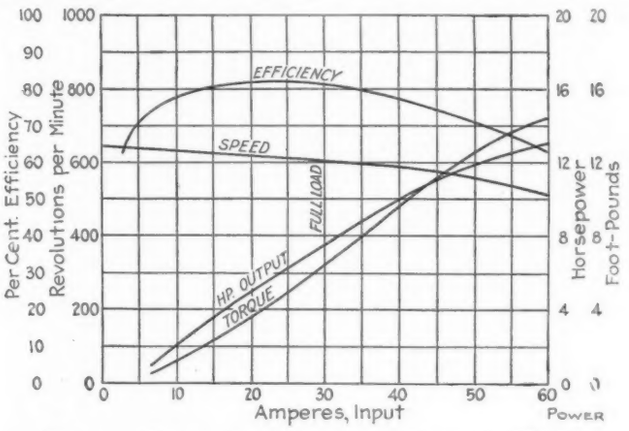


FIG. 6. CHARACTERISTICS OF COMPOUND MOTOR

the counter voltage. Therefore, an increase in voltage is not attended by as great a speed change for a compound-wound motor as would be the case were a shunt motor used. For this service then, the compound motor operates more uniformly.

SPEED CONTROL

It will be noted that in the types mentioned, the changes in speed are automatic, a given speed in each case corresponding to a given load. However, it is possible to control the speed of a direct-current motor by external

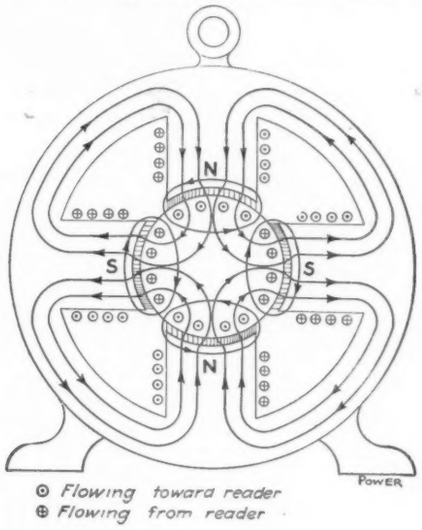


FIG. 7. ILLUSTRATING CROSS-MAGNETIZING EFFECT

means. Returning to the fact that the speed is dependent upon the intensity of the field magnetism, it will be seen that if the field current be changed the magnetism is changed and the speed is affected in a corresponding degree. Therefore, if a variable resistance is connected in series with the shunt field of a shunt motor or a compound-wound motor, having a small degree of compounding, it is easy to adjust the speed to any desired point. The speed will then remain approximately constant at that point regardless of changes in load. The motor is designed to operate at the lowest speed in its range as a simple shunt motor. As resistance is introduced into the shunt field circuit, the speed increases until a point is reached such that centrifugal stresses or commutating conditions prohibit further increase. Motors are commercially built with speed ratios of two to one, three to one or four to one, and they have been built for ratios as high as six to one. In other words, the maximum speed may be two, three, four, five or even six times the minimum speed and the motor may be operated at any intermediate speed, the number of increments of speed depending upon the number of divisions of resistance in the controller.

The factors which limit the horsepower rating of an adjustable-speed motor are heating and commutation, the maximum temperatures being obtained ordinarily when operating at minimum speed. Consequently the frame size must correspond to that of a constant-speed motor rated at the speed corresponding to the minimum speed of the adjustable-speed motor. A 5-hp., 400/1600-r.p.m., adjustable-speed motor and a 5-hp., 400-r.p.m., constant-speed motor are approximately the same size. Motors designed for low speeds are much larger and more ex-

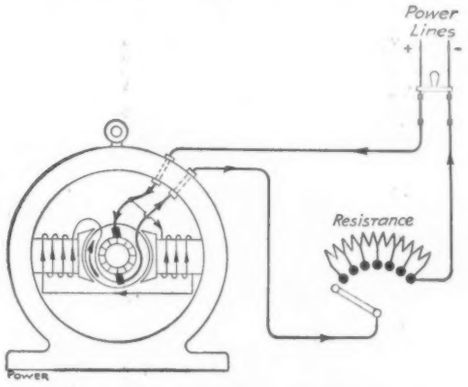


FIG. 8. SHUNT MOTOR WITH RESISTANCE IN SERIES WITH ARMATURE

pensive than those delivering the same horsepower at higher speeds, due to the larger torque required per horsepower output at low speeds. This being the case, a drive using a variable-speed motor is usually more costly than one using a high constant-speed motor with mechanical speed-changing devices.

COMMUTATING POLES

As previously stated, speed control in adjustable-speed motors is obtained by decreasing the field magnetism. When the field is weakened the effects of "armature reaction" are apt to cause sparking at the brushes. The armature is made up of an iron drum with coils embedded in slots in its surface. The current flowing in these armature coils when the motor is under load sets up a magnetic field acting in a way similar to an electromagnetic coil; this action will be seen from Fig. 7, which illustrates the cross-section of a motor and the so called "cross-magnetizing" effect of the field set up by the current in the armature coils. This action is called armature reaction and its effect is to shift the "neutral point" or position where the brushes should be located. The greater the load the more the neutral point is shifted in a direction against the rotation. When the field is weakened in an adjustable-speed motor the relative effect of the armature magnetizing force is greatly increased.

the neutral is shifted quite materially and sparking results.

It has been discovered that a set of narrow poles may be introduced midway between the main poles and if these are properly magnetized they will oppose the cross-magnetizing effect of the armature. As the latter is roughly proportional to the load the magnetizing effect of these "interpoles" should change in a like manner. This result is attained by connecting the interpole coils in series with the armature so that the same current flows through the interpole and armature circuits. Practically all adjustable-speed motors are now supplied with interpoles, and they are also being used extensively in constant-speed motors for 500-volt service or wherever commutation is likely to be imperfect without their use.

Adjustable-speed motors are widely used for individual drives where speed control is desirable, especially for machine-tool work. The ease with which the speed may be changed is a strong factor in obtaining maximum production from all machines, the outputs of which are dependent upon the speed.

The speed of a motor may be decreased by decreasing the voltage impressed upon the armature. This is due to the fact that when the impressed voltage is reduced the counter voltage needed is also reduced and the motor will decrease its speed to decrease the counter voltage. Fig. 8 shows a shunt motor with a resistance connected in series with the armature circuit. The armature current flowing through this resistance causes a drop in voltage, so that the voltage at the armature terminals is less than that of the line. By changing the amount of resistance in the controller, the speed of the motor is adjusted. This method of speed control has two great disadvantages for most service requirements; namely, unsteadiness and inefficiency. If an increase of load occurs, the armature current will be strengthened and this increased current through the controller resistance causes a greater drop in voltage at the armature terminals; the speed, therefore, drops. It will be seen then that with this method of control the speed fluctuates with every change of load.

It will be remembered that for the field-control method of adjusting speeds, a resistance was inserted in the shunt-field circuit. The shunt-field current being only about 2 per cent. of the total current, the loss of power through the inserted resistance is small. In the armature-resistance method of control, the entire load current passes through the resistance, and a considerable loss of power results.

The armature-resistance method is used almost exclusively for traction service, for cranes and hoists and for operations where the speed is constantly manually adjusted. It is also used for printing-press drives and for blowers and fans where the maximum motor capacity is required at high speeds, where the torque at a given speed is quite constant and where the reduction of load under decreased speeds lessens the losses considerably.

The armature resistance method of speed control is used in practically all sizable direct-current motors at the starting period. The load current in a motor was shown to be controlled by the counter voltage. At the instant of starting the motor from rest, no counter voltage exists and if the full line voltage were impressed upon the terminals of a motor at rest, an enormous current would flow through the armature, causing trouble and likely affecting the source of power. To obviate this the motor is first connected to the line through a resistance in series with the armature. This is cut out in steps as the motor attains speed and the starting current is kept within the limits of usually 150 per cent. full-load current. This starting arrangement is called a starting box or rheostat, and is shown in Fig. 9. Most starting boxes are provided with a no-voltage release attachment, which automatically holds the starting lever in running position, as long as the line voltage holds. In case the supply voltage fails, the lever is released to the off position, so that full voltage cannot be impressed upon the motor at rest.

Fig. 9.

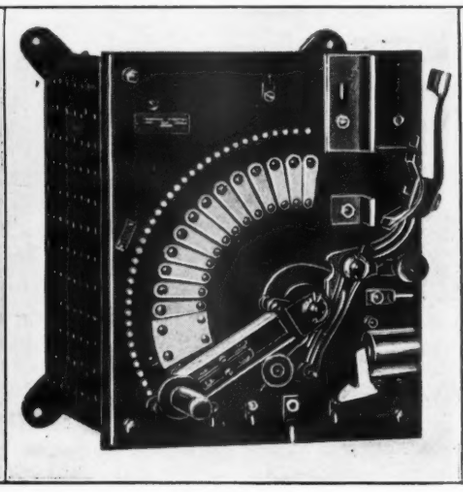


Fig. 10.

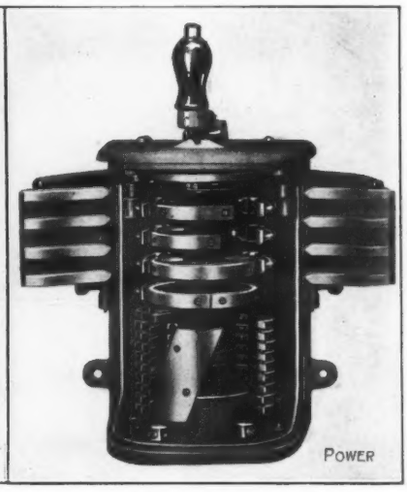


Fig. 11.

Types of Starting Rheostats

Fig. 10 illustrates a starting box combined with field-control resistance. The circuits are arranged so that the motor is brought up to speed with full line voltage impressed upon the shunt field. The field being strong the starting torque is heavy and the starting current low. The large segments are the starting contacts and the small segments are the field-control contacts.

Fig. 11 shows a drum controller. These are largely used with series motors, and are often provided with a magnet which draws the arcs at the contact points.

Fuel Economizers

By Lewis Jones

SYNOPSIS—A short statement of the conditions which determine whether the installation of a fuel economizer is likely to prove profitable or economical.

A fuel economizer is usually made of vertical cast-iron tubes, arranged in banks in the path of the hot flue gas between the boiler and the uptake, through which the feed water passes in a counter direction toward the boiler. Heat is transferred to the water in proportion to the temperature difference between the gas and water and the area of the tube surface. Ordinarily from 25 to 35 per cent. of the total heat of the fuel escapes by way of the chimney. All of the heat abstracted by the economizer from the flue gases constitutes a proportionate gain.

The function of the economizer is identical with that of the feed-water heater using exhaust steam. The difference is in the temperature of the exhaust steam and that of the flue gas; the former, at atmospheric pressure, is only 212 deg. F., while the latter sometimes ranges as high as 600 to 700 deg. Therefore, the water can be raised to a much higher temperature in the economizer than in the exhaust-steam heater.

There is another advantage in heating the water to a high degree before it enters the boiler—i.e., the scale-forming elements in the water are, to a large extent, arrested and precipitated into the sediment chamber of the economizer in the form of sludge, which can be easily washed out and does not enter the boiler. The same result is sometimes accomplished by using a live-steam heater. As the exterior surfaces of the economizer tubes accumulate soot rapidly, on account of the lowered gas temperature and the sweating effect, mechanical scrapers are almost always provided; they, however, must be in constant motion to keep the tubes reasonably clean. The efficiency of the economizer, like that of a boiler, decreases rapidly with the accumulation of soot.

The proportion of heating surface in the economizer to that of the boiler or boilers to which it is connected, depends on the relation of the heating surface to the grate area in the boiler and on the operating conditions in general. If, for any reason, the boiler is unable to abstract the heat generated in the furnace, the flue gas will be excessively hot, requiring a greater amount of surface in the economizer to take up this heat. At the same time, it will increase the temperature of the feed water to a greater extent, and will effect a higher evaporation per pound of coal. The proportions recommended by the manufacturers are from 2½ to 5 sq.ft. of tube surface per boiler horsepower, or from ¼ to ½ the boiler-heating surface, when the flue gas ranges from 350 to 650 deg.; when its temperature is not over 350, there is little benefit in allowing more than 2½ sq.ft. of surface per boiler-horsepower in the economizer.

The returns to be expected will be from 15 to 35 per cent. in capacity and from 7 to 15 per cent. in economy. It is obvious that the percentage of saving (economy) and the increased capacity need not necessarily be the same, because the evaporation per pound of coal may be better, while the demand for steam remains the same; or, in the other case, the capacity may be greatly increased by sacrificing the economy to this end.

Whether the results are likely to be satisfactory will depend on the purpose—i.e., whether to supply a demand for increased steaming capacity or for economy in the use of fuel.

The two questions are: If intended for greater capacity, will it supply the desired amount, or will an additional boiler be more desirable or even ultimately necessary? If for economy, will it pay as an investment?

The capacity is mentioned first because, if it is to be depended upon for a definite increase in steaming capacity, greater care is necessary to obtain data in order not to be disappointed, if a certain increase in *capacity* is imperative and the economizer fails to produce it, the condition is more serious than if a certain *economy* is expected but not realized.

Primarily, the temperature of the flue gas should be tested. If it is high, why is this so? Is it because the boiler is operated beyond its economical capacity and the heating surface is insufficient, or is it because the boiler is foul from soot and scale? If the former, an economizer will increase both the capacity and the economy of the plant. If the latter, it is likely that little benefit will be derived, notwithstanding the high gas temperature, because the economizer is also likely to be neglected. Will the 15 to 35 per cent. of extra capacity be sufficient, or will an extra boiler also be necessary with the economizer?

If considered for economy and not extra steaming capacity, will it pay as an investment? The accepted average saving in fuel is one per cent. for every 11 degrees increase in temperature in the feed water, or a fuel saving ranging from 7 to 15 per cent., less the operating costs.

The difference in the temperature of the gas on entering and leaving the economizer will indicate the amount of heat absorbed by the water. This, in turn, is determined by the temperature of the feed water on entering and leaving the economizer. If no exhaust is available to heat it, then the economizer has the entire heating function to perform, and will produce correspondingly greater results as the entering water is colder.

It is important that the temperature at which it is sent to the economizer should not be less than about 100 deg.; in many cases, the temperature is considerably below this, and causes what is known as dewing or sweating of the pipes. The result is that the vaporous portions of the flue gas condense on the bottom boxes and lower ends of the pipes, causing rapid corrosion; also, the soot cakes hard on the tubes and in time prevents the scrapers from working.

The counterflow principle allows the colder feed water to come into contact with the cooler gas, and advance

The kind of draft, natural or artificial, also enters into the investment consideration. If natural draft is abundant, it is likely to cause excessive air in the furnace, with low CO_2. The greater the excess of air used per pound of coal burned, the greater the proportion of saving the economizers should show. An economizer will tend to correct both losses by slightly reducing the draft, and also by absorbing the heat from the excess heated air. If, however, the natural draft is near the minimum, it is likely that the reduction in the gas temperature and the obstruction by the economizer will prove too much, re-

quiring a forced or induced-draft fan equipment. In this case, the first cost is enhanced and the operating cost is greater; therefore, the proposition becomes less attractive. If, in the third case, the draft is bad, a fan will prove profitable with or without the economizer, and should not be charged against the first cost of the economizer equipment; nor should all the good results be attributed to the economizer.

The loss in draft in the economizer is from 0.15 to 0.40 in. of water. Cost of maintenance and upkeep must be taken into account, because no part of the plant will show a wider range of results due to care or neglect than an economizer. Therefore, if the plant is kept in the best condition, and the best results are obtained with a given equipment, the economizer will probably be well taken care of and prove a good investment; but if losses are due to neglect or ignorance of either the employer or the employee, then the addition of an economizer becomes a questionable proposition, or even detrimental and sometimes dangerous.

Down-Draft Furnaces*

By Osborn Monnett†

SYNOPSIS—Principles of operation, provisions for preventing smoke and how to fire this type of furnace.

These furnaces depend for their success on the fact that the volatile matter must pass down through the bed of fuel and over the coked coal on the lower grate before entering the boiler. In this way the gas is exposed to a high temperature, and if the proper amount of air is admitted through the middle door, it will be consumed without making smoke. When poking the fuel bed, it frequently happens that considerable green coal will be brought down on the lower grate; it will smoke unless special precautions are taken.

Fig. 1 shows a typical down-draft furnace connected to a horizontal return-tubular boiler. If operated rightly, this furnace can be run without dense smoke, but with the ordinary fireman there are periods when, through careless operation, a quantity of volatile matter passes the bridge-wall without being consumed and escapes as smoke. To get the best smokeless results on this furnace, some additional protection against these periods is necessary. Fig. 2 shows a down-draft setting with a deflection arch and with the bridge-wall arranged to give the maximum deflection of the gases. This arch mixes the gases thoroughly before they pass away from the furnace and is of great aid in preventing smoke.

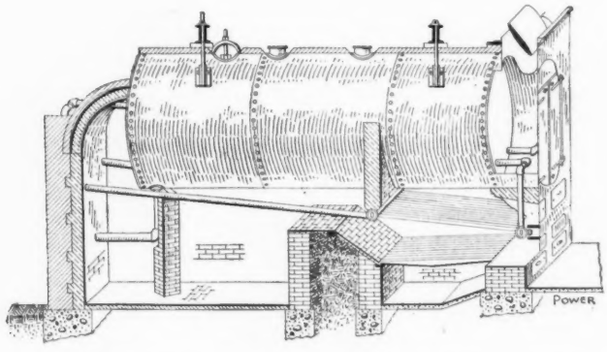


Fig. 1 Ordinary Installation of Return-Tubular Boiler and Down-Draft Furnace

Another step taken to increase capacity and lessen smoke is shown in Fig. 3. It is a modification of the standard double-arch, bridge-wall setting as used for hand-fired settings, in connection with a deflection arch as before. This construction seems to have a marked effect on the rate of combustion and consequently the capacity of the boiler and also on the smoke. If properly operated, it is as nearly smoke-proof as any semi-stoker or hand-fired arrangement can well be.

Fig. 4 is a working drawing of a down-draft furnace and a single-span deflection arch in connection with a 60-in. by 18-ft. boiler. With this as a guide, a setting for any size of boiler can be worked out, using the same rules for areas of gas passes that have been previously set forth for hand-fired furnaces with deflection arches.

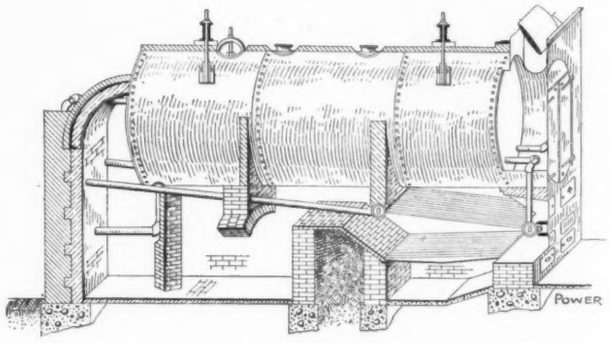


Fig. 2. Down-Draft Furnace with Deflection Arch in Combustion Chamber

In combination with water-tube boilers, the down-draft furnace can be easily applied, the principal requirement being that the boiler must be horizontally baffled. Fig. 5 shows a standard Kroeschell setting with down-draft grates and a two-span deflection arch. This makes a good hand-fired, flush-front outfit for moderate rates of combustion.

It is not feasible to apply the down-draft furnace to vertically baffled water-tube boilers and still get the desirable flame travel and mixture. While a few such settings exist, for power loads the design cannot be considered good for smokeless operation with high-volatile coals.

Building Fires

Cover the lower grate with coal and build a wood fire on top, keeping the middle doors cracked for the panels wide open. After this fire is well started, throw a little wood on the upper grate and cover it with coal, allowing this fuel to be ignited from the lower fire.

*Copyright, 1914, by Osborn Monnett.

†Smoke inspector, city of Chicago.

In regular firing, after a good bed of coals has been formed on the upper grate, poke the coked coal down on the lower grate and cover the upper grate with fresh coal, keeping the fuel bed at thick as the draft will permit; the thicker the better. When poking down, always crack the middle door to allow plenty of air to take care of any volatile matter which may pass off. The more coal kept on the upper grate, the thicker will be the bed of coked coal, and consequently the less chance of making smoke. Never poke down until the coal on the upper grate is thoroughly coked. Be careful that no green coal comes down on the lower grate. Regulate the steam by opening or closing the front firing doors. The less the lower grate is disturbed, the better. There should be no regular cleaning period for the lower grate as is common for the ordinary, hand-fired grates. Clinkers should be pulled out from time to time without disturbing the coked coal, thereby always keeping the lower fire in good shape.

The secret of success with this type of furnace is to fire heavily on the upper grate; it permits long periods between firing, during which there is a thick bed of coal being coked. When the fire is poked down, this thick bed insures that there will be no green coal falling on the lower grate. In this way, the fires need be disturbed only at infrequent intervals and there is no danger of dense smoke if ordinary care is exercised. This type of furnace should not be expected to run at a rate of combustion higher than 25 lb. of coal per sq.ft. of grate surface per hour, based on the area of the lower grate. Above this rate the chances of making smoke are increased, due to frequently disturbing the fire. Below this rate the furnace is eminently suited to the work and it is not necessary to be particular as to the kind of coal used, although a 4-in. run-of-mine coal is ideal for a down-draft furnace.

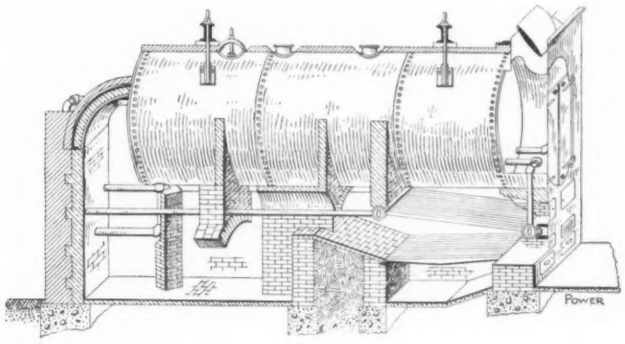


FIG. 3. DOWN-DRAFT FURNACE WITH DOUBLE-ARCH BRIDGE-WALL AND DEFLECTION ARCH

Safety First—The "Safety-First" slogan is a practical, worthy attempt. Results, however, can only be reached when all unite in an effort to further the commendable work.

Belt Cement—The following is the composition and use of a belt cement which is said to work equally well on leather and rubber belts: Carbon bisulphide 10 parts, mixed with turpentine one part, with enough gutta percha dissolved in the mixture to make a thin syrup. Both parts of the leather to be joined must be clean, and if they are greasy they should be laid on a clean rag and a hot flatiron placed on them so as to draw the grease up and let it be absorbed by the cloth. When the surfaces are free from grease they are coated with the cement and kept pressed together until the joint has set hard.

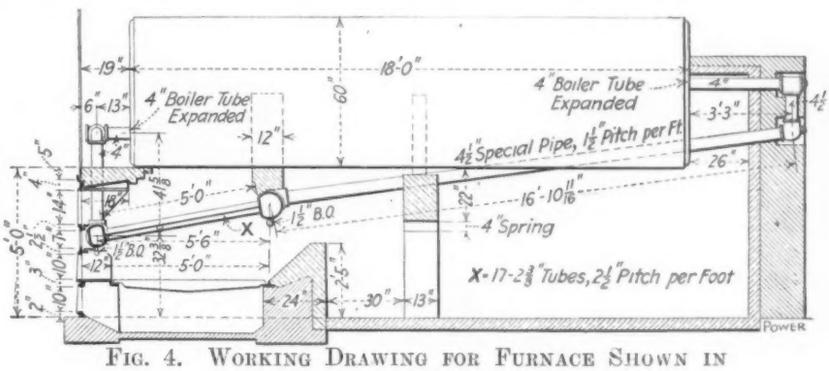


FIG. 4. WORKING DRAWING FOR FURNACE SHOWN IN FIG. 2, 5x18-FT. BOILER

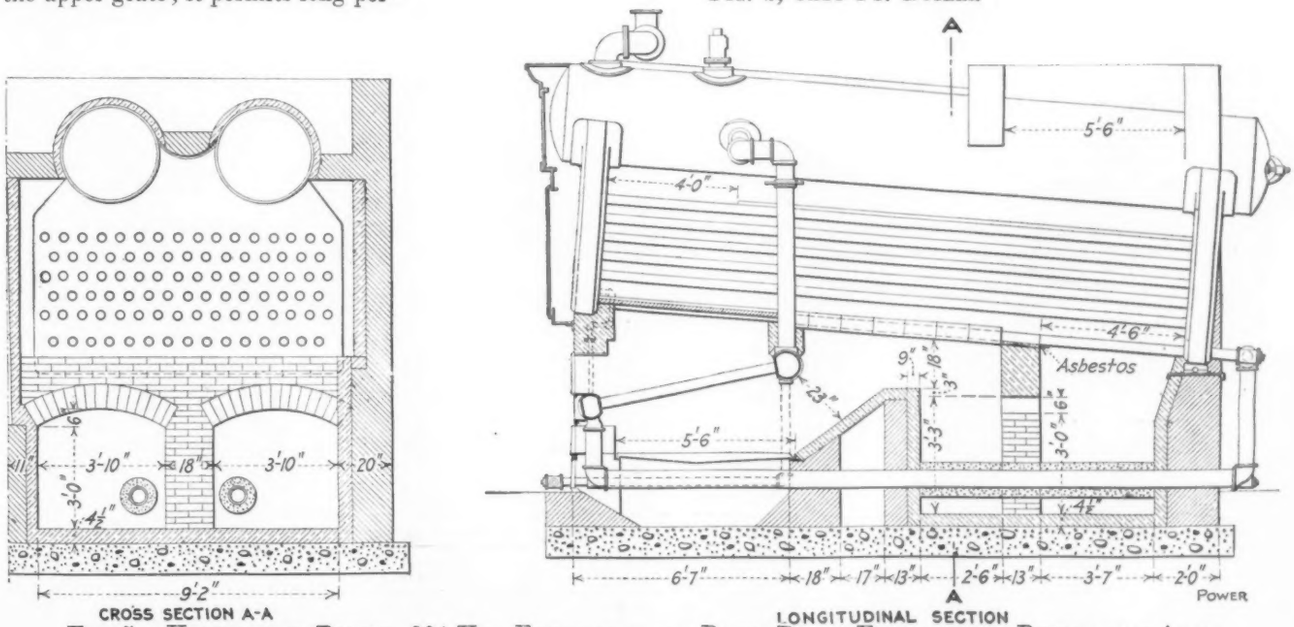


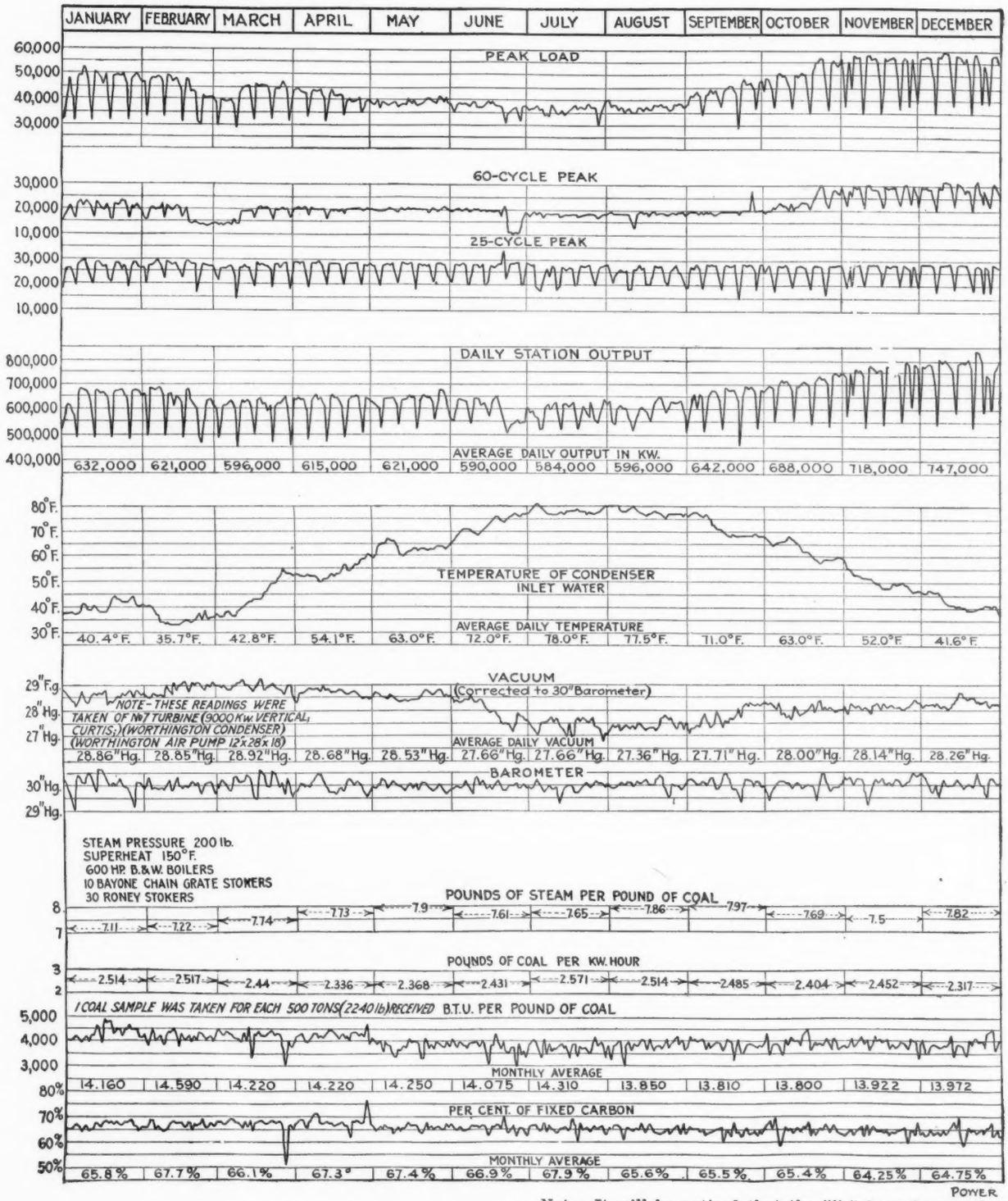
FIG. 5. KROESCHELL BOILER, 204-HP., EQUIPPED WITH DOWN-DRAFT FURNACE AND DEFLECTION ARCH

Performance of Marion

The Marion (Jersey City) Station of the Public Service Corporation of New Jersey, located on the Hackensack River, is the largest of this company's many power stations. The accompanying curves show in detail the performance of the station for 1913.

Notice that the coal used is higher in volatile than that used in most stations, running as high as 29 per cent. at times with an average of 24.7 per cent. for the year. The location favors this coal as far as smoke is concerned, but as it is a rather long-flame coal the floor under some of the boilers has been lowered two feet and more to give additional furnace height.

Usually in calculations the average temperature of circulating water is taken as 65 or 70 deg. F. It is inter-


JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
60,000 50,000 40,000 30,000
PEAK LOAD
30,000 20,000 10,000
60-CYCLE PEAK
30,000 20,000 10,000
25-CYCLE PEAK
800,000 700,000 600,000 500,000 400,000
DAILY STATION OUTPUT
AVERAGE DAILY OUTPUT IN KW.
632,000 621,000 596,000 615,000 621,000 590,000 584,000 596,000 642,000 688,000 718,000 747,000
80°F. 70°F. 60°F. 50°F. 40°F. 30°F.
TEMPERATURE OF CONDENSER INLET WATER
AVERAGE DAILY TEMPERATURE
40.4°F. 35.7°F. 42.8°F. 54.1°F. 63.0°F. 72.0°F. 78.0°F. 77.5°F. 71.0°F. 63.0°F. 52.0°F. 41.6°F.
29"Hg. 28"Hg. 27"Hg.
VACUUM
(Corrected to 30" Barometer)
NOTE-THESE READINGS WERE TAKEN OF No 7 TURBINE (9000 Kw. VERTICAL, CURTIS;) (WORTHINGTON CONDENSER) (WORTHINGTON AIR PUMP 12x28x18)
AVERAGE DAILY VACUUM
28.86"Hg. 28.85"Hg. 28.92"Hg. 28.68"Hg. 28.53"Hg. 27.66"Hg. 27.66"Hg. 27.36"Hg. 27.71"Hg. 28.00"Hg. 28.14"Hg. 28.26"Hg.
30"Hg. 29"Hg.
BAROMETER
STEAM PRESSURE 200 lb.
SUPERHEAT 150°F.
600 HP. B.&W. BOILERS
10 BAYONE CHAIN GRATE STOKERS
30 RONEY STOKERS
8 7
POUNDS OF STEAM PER POUND OF COAL
7.11 7.22 7.74 7.73 7.9 7.61 7.65 7.86 7.97 7.69 7.5 7.82
3 2
POUNDS OF COAL PER KW. HOUR
2.514 2.517 2.44 2.336 2.368 2.431 2.571 2.514 2.485 2.404 2.452 2.317
5,000 4,000 3,000
1 COAL SAMPLE WAS TAKEN FOR EACH 500 TONS (2240 lb) RECEIVED B.T.U. PER POUND OF COAL
MONTHLY AVERAGE
14.160 14.590 14.220 14.220 14.250 14.075 14.310 13.850 13.810 13.800 13.922 13.972
80% 70% 60% 50%
PER CENT. OF FIXED CARBON
MONTHLY AVERAGE
65.8% 67.7% 66.1% 67.3° 67.4% 66.9% 67.9% 65.6% 65.5% 65.4% 64.25% 64.75%
POWER.

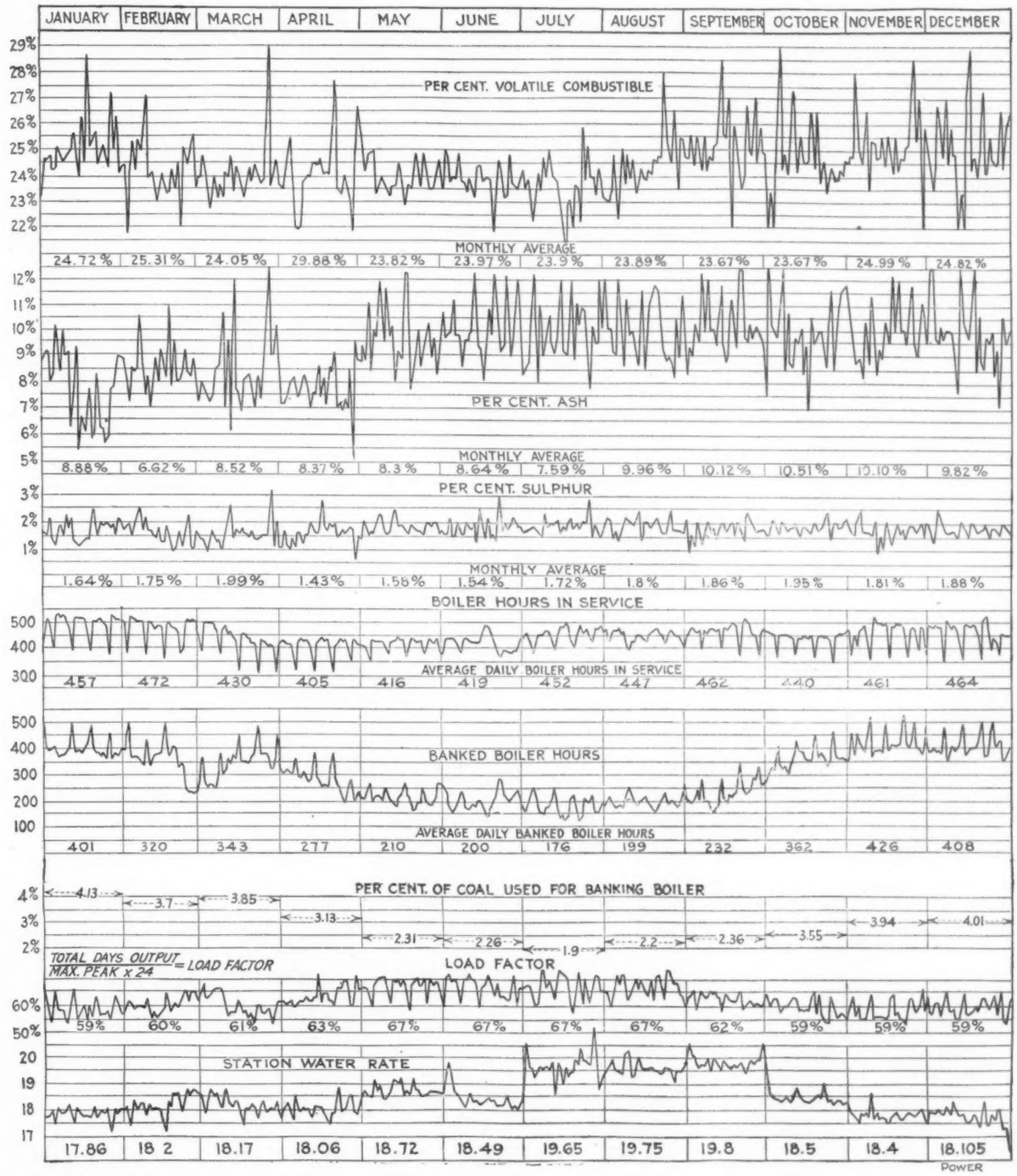
Note—It will be noticed that the "1's" have been unintentionally omitted in the figures giving the heat values of the coal; they should, of course, be 13,000, 14,000 and 15,000.

Station for the Year 1913

esting, therefore to note that the average temperature at Marion was 57.5 deg. F., with a maximum of 82 and a minimum of 33 degrees. Notice that this curve is comparatively flat for July and August. The barometer shows a much wider variation for January than for any other month.

The steam rate for July, August and September is quite perceptibly higher than for any other three months, being 1.65 lb. higher than for January, February and March. This is due chiefly to the vacuum owing to the warmer condensing water used in the summer months. For January, February and March the average vacuum was 28.88 in., while during July, August and September the average was 27.53.

The coal used per kilowatt-hour for the year averages 2.44 lb. This is not a bad showing when it is considered that all standby, leakage and blowoff losses are included in this figure. This is 0.696 lb. higher than the figure given


JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
PER CENT. VOLATILE COMBUSTIBLE
MONTHLY AVERAGE
24.72% 25.31% 24.05% 29.88% 23.82% 23.97% 23.9% 23.89% 23.67% 23.67% 24.99% 24.82%
PER CENT. ASH
MONTHLY AVERAGE
8.88% 6.62% 8.52% 8.37% 8.3% 8.64% 7.59% 9.96% 10.12% 10.51% 10.10% 9.82%
PER CENT. SULPHUR
MONTHLY AVERAGE
1.64% 1.75% 1.99% 1.43% 1.58% 1.54% 1.72% 1.8% 1.86% 1.95% 1.81% 1.88%
BOILER HOURS IN SERVICE
AVERAGE DAILY BOILER HOURS IN SERVICE
457 472 430 405 416 419 452 447 462 440 461 464
BANKED BOILER HOURS
AVERAGE DAILY BANKED BOILER HOURS
401 320 343 277 210 200 176 199 232 362 426 408
PER CENT. OF COAL USED FOR BANKING BOILER
4.13 3.7 3.85 3.13 2.31 2.26 1.9 2.2 2.36 3.55 3.94 4.01
TOTAL DAYS OUTPUT / MAX. PEAK x 24 = LOAD FACTOR
LOAD FACTOR
59% 60% 61% 63% 67% 67% 67% 67% 62% 59% 59% 59%
STATION WATER RATE
17.86 18 2 18.17 18.06 18.72 18.49 19.65 19.75 19.8 18.5 18.4 18.105
POWER

Note—The above figures are not the average of the station water-rate curve, but are the averages of the above curve plus steam used by cable testing, construction, and condensation losses.

by the Boston Elevated Railways Co., for the performance of its South Boston Station for 1913, the consumption being 1.744 lb. per kilowatt-hour including losses for banked fires and leakage. The coal used in the South Boston Station has about the same heat value as that used in Marion and is straight bituminous slack.

The curve showing the percentage of the total coal used for banked fires follows the station and peak load curves very well, reaching a maximum of 4.13 per cent. for January as against a minimum of 1.9 per cent. for July, the average for the year being 3.1 per cent., or almost exactly the percentage used in April.

Comparative Tests with Low-Grade Oils

By Dr. F. E. Junge

SYNOPSIS—Results of tests on a Junkers engine to determine the performance with different low-grade oils, including those of asphaltic base and coal-tar oil.

The increasing application of liquid fuels for purposes of power generation, where weight, space and economy are limiting conditions, has made it necessary to turn from the use of high-grade oils, so far employed, to the utilization of lower grades, which are available all over the world in large quantities or remain suitable for further use as byproducts of the distillation of coal and crude mineral oils.

In the following, the results of fuel-consumption trials on a Junker engine are given, containing, among others, the results of tests made with Californian and Mexican crude oils, the lowest grade of liquid fuels in existence. The engine used in these tests had a cylinder diameter of 7.8 in. and a stroke of 2 × 15.6 in. (two opposing pistons being employed). The speed was 200 revolutions per minute, the normal load 150 horsepower, and an overload attained of 220 horsepower. The engine has two cylinders arranged in tandem, but having been designed for experimental purposes and being the first double-piston engine of its type actually built, it contains few of the many improvements which have since been made; therefore the results are not as favorable as would be expected with a later design. Also, for experimental purposes, it is equipped with much larger pumps and compressors than necessary for normal working, the scavenging pumps having nearly twice and the compressors nearly five times the normal capacity.

Gas Oil

The gas oils experimented upon were purchased from different quarters, namely, Pechelbronn, Alsace, Messel, near Damstadt, and Wietze, near Hanover; Roumanian and American gas oils were also tested. The analysis of the oils and the results obtained are compiled in the accompanying table. It may be added that the engine was run for several hours at 30 and 40 r.p.m. at 20 per cent. turning moment. After stopping two hours the engine started on gas oil without the use of compressed air.

Attention is called to the high mean pressure and to the high thermal efficiency attained. The fuel-consump-

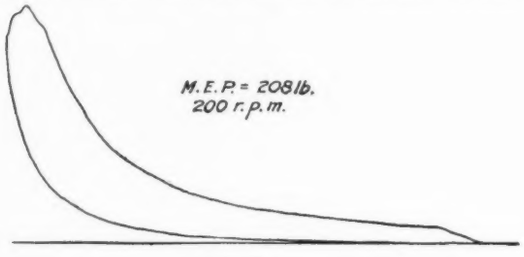


FIG. 1

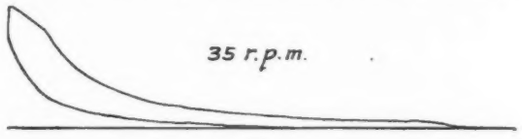


FIG. 2

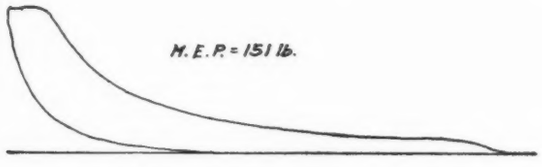


FIG. 3

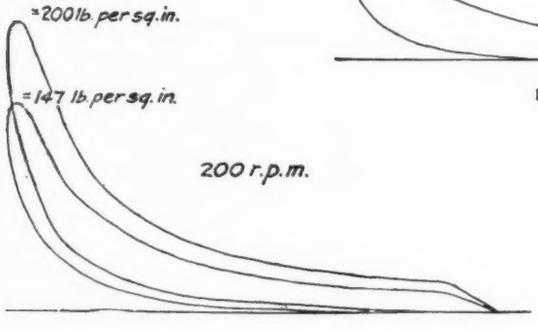


FIG. 4

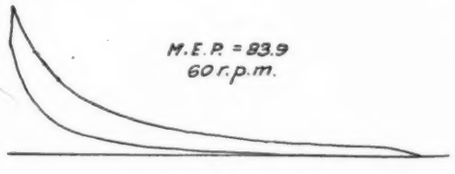


FIG. 5

Indicator Diagrams with Different Oils as Fuel

tion figure in the first column refers to gas oil having a calorific value of 10,000 calories per kilogram or 18,000 B.t.u. per pound.

Pacura Oil

It was decided that long duration trials should be made in frequent intervals, in preference to continuous trials, the former being more likely to show any tendency to leave a deposit on the pistons or cylinder walls. Altogether 6600 lb. of Pacura were consumed during the trials. Immediately afterwards the pistons were taken out and an examination of the cylinder, ports, pistons, and fuel valve showed them to be clean. There was no disturbance whatsoever during the whole of the trials and the fuel consumption remained constant, averaging 0.44 lb. per brake-horsepower per hour. The thermal efficiency showed a mean value of 31.6 per cent. and the mean effective pressure was in the neighborhood of 160 lb. Pacura is a Roumanian residue oil, the specific gravity and flash point of which are given in the table.

Californian Oils

Two brands of this oil were tried in the engine, Californian residue, brand "L," and Californian crude oil, brand "K"; both were obtained from the Amalgamated Oil Company's refinery at Los Angeles. Analysis of the latter is given in the table. The trials extended over a period of four weeks, the aggregate period of operation being 126 hours. An overload run was also made, followed by a number of trials at low speeds, 25 to 30 r.p.m. being maintained with uninterrupted positive ignition. Attention is called to the high contents of asphaltum in the fuel, in spite of which no trouble whatsoever was experienced throughout the trials, the pistons, atomizers, fuel valve, etc., remaining untouched during the whole period. After the conclusion of the trials when about 11,000 lb. of oil had been consumed, the pistons and other working parts were removed, inspected and photographed. There was no deposit on the piston heads and the nozzles were clean, proving that the temperatures in this type of engine combined with the perfect process of scavenging and charging were capable of consuming Californian crude oil completely. The indicator diagrams, Figs. 1 and 2, are particularly interesting, because the first was taken under abnormal conditions of overload, showing a mean pressure of 208 lb., while the latter shows perfect ignition at 35 r.p.m.

Mexican Crude Oil

This oil was supplied by the Huasteca Petroleum Co., of Ebano, Mexico, and its analysis shows it to be about the worst fuel obtainable, containing as much as 45.6 per cent. asphaltum and 2.4 per cent. sulphur. The engine was run on this oil each day for a period of 10 to 12 hours, altogether 200 hours. One day it was run for 11 hours on 50 per cent. overload, but in spite of the high percentage of asphalt, it is said to have operated throughout the trials without the slightest trouble. At speeds as low as 25 and 40 r.p.m., ignition was positive and the engine ran well. The indicator diagram in Fig. 3, taken at normal load, shows a mean effective pressure of about 151 lb.

Russian Masut

Analysis of this oil showed the incombustible matter to be made up to 1.06 parts water and 0.37 part ash, making a total of 1.43 per cent. A long duration trial of 75 hours was held during which no difficulty whatsoever occurred and the exhaust was always invisible. An inspection of the internal working parts immediately after the termination of the trials showed all parts to be in good condition.

German Coal-Tar Oils

This oil had lower calorific value and a higher carbon content than the other fuel oils. Its specific gravity was also higher. The engine ran well and started easily without the use of ignition oil. The indicator diagrams, Fig. 4, at normal load and overload, shows the more spontaneous character of ignition of the coal-tar oils compared to other fuels. The last indicator diagram, Fig. 5, shows the engine at 60 r.p.m., that is about one-third normal speed, and at one-third normal load, running on tar oil alone and igniting with ease and certainty.

RESULTS OF TRIALS WITH DIFFERENT OILS

Analysis of oil	Gas Oil	Pacura	Calif. Oil	Mexican Oil	Masut	Coal Tar Oil
Heat value, B.t.u. per lb.	18,000		17,400	17,460	17,800	15,950
Carbon, per cent.	86.98		84.0	83.21	85.67	90.12
Hydrogen, per cent.	12.15		11.07	11.32	12.13	7.09
Sulphur, per cent.	0.71		0.87	2.47	0.05	0.63
Oxygen, per cent.	0.16		3.93	2.90	0.72	1.66
Incombustibles, per cent.	0.00		0.13	0.14	1.43	0.50
Specific gravity	0.850	0.90	0.864	0.937	0.900	1.065
Viscosity	1.14		6.41	4.11	19.96	1.66
Flash point, deg. C.	80	140	137		113	98
Asphaltum, per cent.			48.1	45.6		
Average mean ind. pressure, lb. per sq.in.	154.4	161.7	155.8	147.0	158.6	147.0
Thermal efficiency, per cent	33.1	31.6	30.5	30.4	31.8	32.1
R.p.m.	200	205	200	200	200	200
Brake hp.	160	154	151	145		144
Fuel consumption, lb. per b.hp.-hr.	0.427	0.440	0.480	0.480		0.480

Drinking-Water Systems

Water, when cooled for drinking purposes, is best at from 45 to 50 deg. F. As to the costs of systems for cooling drinking water, it is claimed that in numerous cases a small refrigeration plant with cooling tank and fountains conveniently located has been installed for less than the operating cost for two years with the bucket and dipper method.

The quantity of water required per individual varies with the different industries and climatic conditions. In steel works, where the service is quite severe, it has been found that in summer, from 0.23 to 0.3 gal. per man per hour is necessary, including the waste.

The amount of refrigeration depends on the size of the installation, the length of the distributing lines, the outside temperatures, the temperature of the water, the length of the day in which the system is to be in service and quite important, on the manner in which the pipe lines are insulated. Experience shows that 0.00027 to 0.0005 ton of refrigeration per hour per man is needed.

It is good practice to use galvanized pipe with long sweep fittings for the distributing lines. At the return bend of each circuit a thermometer and a gate valve should be provided for regulating the flow, so as to insure uniform temperature throughout the circuit. Dead ends should, of course, be avoided. Branch circuits will give best results if made not longer than 2000 ft., though some as long as 5000 work quite satisfactorily. One-inch pipe will be found a good size, though the number of drinkers may require larger sizes on some circuits. Extended observations show that a water velocity of not more than 190 ft. per minute gives the best results.

All this is told very clearly in a little booklet containing several photographs and diagrams, as well as an interesting description of the plant at Beaver Falls, Penn., the testing station for the Armstrong Cork & Insulation Co., Pittsburgh, Penn., makers of Nonpareil cork pipe covering. We understand that the booklet may be had for the asking.

Avoidable Heat Losses Prevented

The value of properly and efficiently insulating boiler settings, steam drums and all exposed heated surfaces in boiler rooms was recently demonstrated in the Chamber of Commerce Building, Detroit, Mich. The idea of thoroughly insulating the three 100-hp. water-tube boilers was inspired by the desire to reduce the heat in a storeroom over the boilers.

The steam drums and the tops of the boiler settings were covered with one course of Nonpareil insulating brick set on edge in special insulating cement; in all, 3100 bricks were used. Although the covering on the steam line was equal to that found in the average boiler room, it was replaced in numerous cases by Nonpareil high-pressure steam covering 2 in. thick. The breeching, valves and other irregular surfaces were covered with 2 in. of high-pressure cement.

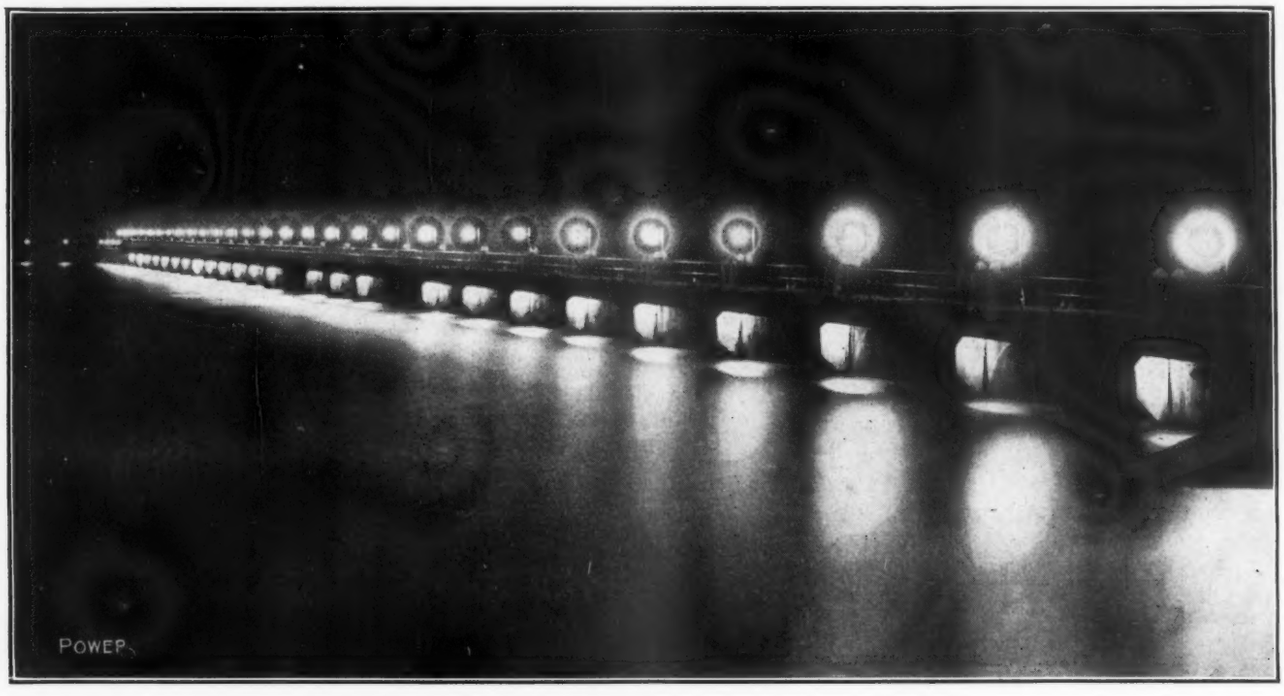
One feature is the removable covers used on the steam-pump cylinders. Forms were made of Hy-Rib metal to which high-pressure cement was applied and afterward covered with canvas.

The result obtained by the use of these insulating materials was that the temperature under the floor of the storeroom above the boilers was lowered 30 deg., and made conditions in the store much more pleasant. The insulating material used was made by the Armstrong Cork & Insulating Co., Pittsburgh, Penn.

Accurate monthly records of the fuel consumption in this plant have been kept for a number of years. Since the load varies but little from year to year, it was a simple matter to compute the fuel saving due to insulation. During the month of April, 1913, 224,960 lb. of coal were consumed, and 229,950 lb. in May of the same year. In April, 1914, after the boilers had been insulated, but 183,190 lb. of coal were used, and in May, 1914, but 181,930 lb. Hence, the saving in April, 1914, over April, 1913, was 41,770 lb., and the saving of coal in May, 1914, over that of May, 1913, was 48,020 lb.

Coon Rapids Dam Illuminated

This dam, which is 2070 ft. long, with a concrete spillway 1000 ft. long, surmounted by 28 Tainter gates, each 33 ft. long and 8 ft. high, has been provided with 100 Mazda lamps, mounted on goose-neck standards. This illumination, illustrated herewith, is for the purpose of making safe passage of persons on the bridge over the dam, to facilitate the work of handling the Tainter gates and for dealing with the ice and log problems which will arise at certain periods of the year.



Coon Rapids Dam, Illuminated with 100 Mazda Lamps

Two of the five generating units in the hydro-electric plant are in operation. The development is leased to the Minneapolis General Electric Co., and was built by H. M. Byllesby & Co., Chicago.

Barometric Condenser Head as Open Heater—A railway master mechanic had use for large quantities of hot water in a roundhouse where there was very little room for a heater. Both live and exhaust steam were available for heating the water, but it was a question of getting a heater of dimensions which could be accommodated in the space. D. D. Pendelton, of the Wheeler Condenser & Engineering Co., suggested that the head of a barometric condenser be used as a mixer for the cold water and steam, and this was done successfully, the installation taking up a very small corner of the house.

Editorials

Large Steam Turbines

The article, "Compound Steam Turbine," in the Sept. 15 issue, and that treating of the Brooklyn Edison Co.'s new turbine, in this issue, are of interest for what they bring out regarding the development of this class of prime mover. To most of us, the chief feature is the great increase in capacities of turbine units in such a few years. In 1900, turbines of capacities greater than 500 kw. were so rare as to be regarded with much interest, particularly by those engaged in the design of this class of machine. Today, units of 20, 30 and even 35 thousand kw. capacity excite only momentary surprise, so rapid has been their development. Any day we may learn that some builder is beginning the construction of a 50,000-kw. unit, and there is no doubt that, with the cross-compound principles of design as adopted for the new 30,000-kw. unit for the 74th St. station, capacities greater than this are possible.

It will be with much interest that engineers will watch the operation of these immense compound units. Mr. H. G. Stott, superintendent of motive power for the Interborough Rapid Transit Co., always an original man and one of the foremost in the art, is as confident of their success as he was sure that he could safely and economically operate boilers considerably above their rated capacities, a practice that has been widely adopted, and one in which he was a pioneer. It is with the same feeling that Mr. Hodgkinson, designer of these machines, has completed his work.

The turbine for the Gold St. station of the Edison Electric Illuminating Co., of Brooklyn, is the largest single-cylinder unit, being of 25,000 kw., maximum rating. Additional interest is induced because of the use of single and compound construction for large turbines. Much apprehension was felt by foreign engineers when American designers put forth a unit of 2000 kw. with a single cylinder in 1900. Dangerously severe distortions were expected in so large a machine, due to the extreme temperature differences along the structure. European designers were then building 1000-kw. units with two cylinders placed tandem. Convinced of the superiority of the two-cylinder arrangement, American engineers adopted it, while at the same time those abroad increased the capacities of their single-cylinder machines, but apparently considered that a safe limit was reached for this design at a capacity below that practiced by American engineers. The Parsons 25,000-kw. machine for the Chicago Commonwealth Edison Co. is a two-cylinder tandem unit, while the Westinghouse machine for the Brooklyn Edison Co. has a maximum capacity of 25,000 kw., and is of the one-cylinder, double-flow type. Basing the areas occupied on over-all lengths and greatest widths, the Chicago machine develops 17.3 kw. per sq.ft. of floor space, while the Gold St. turbine produces 30.4 kw. for the same unit of area.

The increase in speed along with capacity is another point of interest. Especially is this so when we consider that for 25-cycle work, 3000 kw. was the highest capacity at the speed of 1500 r.p.m. in 1905, while the 22,000-kw. (normal rating) Brooklyn machine runs at 1500 instead of 750 revolutions. Relative to speed, it is of interest to know that the 20,000-kv.a. (80 per cent. power factor) single-cylinder turbines now being built by the General Electric Co. for the new Essex station of the Public Service Corporation of New Jersey will run at 1800 r.p.m., the highest attempted in large turbine practice.

As we have probably reached the limit in forms of design for large units, now that the "cross-compound" with two speeds is a reality, we may perhaps look only for continued developments in details.

Waste of Natural Gas

As a result of the general conservation movement promulgated during the past few years, the public, and engineers in particular, have awakened to the necessity of conserving the nation's coal supply, and have responded, in a measure, by furthering hydro-electric development and by practicing boiler-room economy. Up to recently, however, little thought appears to have been given to the enormous waste going on in the oil and gas regions.

Investigations by the Bureau of Mines, the results of which are published in a recent bulletin, show this waste in the midcontinent fields, comprising Kansas, Oklahoma and northern Texas, alone to have been appalling. It is estimated that up to last year, 425 billion cubic feet of natural gas, equivalent in heat value to over 20 million tons of coal, have been allowed to escape, and although the waste has now been curtailed to some extent, it is still over 25 billion cubic feet per year, equivalent to over a million tons of coal. Much of this gas appears in combination with oil, and where there was no immediate market, it was often allowed to go to waste, being regarded merely as incidental to the production of the oil. Only of comparatively recent date have steps been taken to produce gasoline from the gas, but even this process has not become general.

The waste in this region is not confined to the operators alone, for when the gas is collected and piped to consumers, in many cases it is sold at a flat rate, without meters. This, combined with the low price, which for the state of Oklahoma averages about 5c. per 1000 cu.ft., is conducive to the existing practice in many cases of allowing lights to burn night and day, and of regulating the temperature in cold weather by opening outside doors.

While legislative action might be directed at the prevention of such waste, its effectiveness is doubtful, as it would be difficult to enforce any drastic measures of this nature. As in the case of coal, the remedy undoubtedly lies in educating both the producer and the consumer to the economic aspects of the problem in such a way as to show them that they will personally profit by conserving the supply.

The License and Boiler Inspection Law Hearing

The committee appointed by the American Society of Mechanical Engineers to formulate standard specifications for the construction of steam boilers, and the care of the same in service, held a hearing at the Engineering Societies' Building in New York last week, which was the most momentous and potential occasion which has occurred in the battle for legislation for the reduction of boiler explosions and steam-plant accidents.

A seeming attempt to pack the committee interfered with the orderly progress of the proceedings at first, and lack of harmony between the representatives of the railroads and of the steel manufacturers and the committee threatened to prove a serious hindrance to a successful outcome of the work, but the indorsement of the general purpose was so hearty and general, the determination to have some legislation of this kind so positive, that a spirit of compromise prevailed. The committee withdrew some of its most radical provisions without materially affecting the standard of its code, perhaps with the effect of avoiding serious difficulties in its enforcement, and the representatives of the interests professed their satisfaction.

There is evidently still a great amount of work to be done to perfect a code which will take account of the suggestions offered, and the completed report of the committee can hardly be ready before the December meeting of the society. In the meantime, the boiler manufacturers have worked up a live interest in the subject on the part of the governors and legislators of many states, and these are demanding something concrete in the way of a suggestion for their legislatures. Mr. Durban, speaking for the boiler manufacturers, demanded some sort of a result which could be turned over to these people within 30 days, and we understand that a new organization, comprising all the boiler manufacturers, has been formed to meet in Pittsburgh on September 29 and consider methods for promulgating this sort of legislation either by forwarding the work of the American Society of Mechanical Engineers committee, or by getting out a law and standard upon its own hook if the work of that committeee does not progress at a satisfactory rate. The boiler makers are in entire accord with the A. S. M. E. committee, although they may not be particularly interested in an engineer's license law, which is a part of the committee program, and if they go to work independently it will be simply because the society's committee does not keep the pace at which they wish to go.

The main part of this work, however, is to be done upon the code, and the code is no part of the law which will have to be passed by the various states to bring the code into effect. The law provides a Board of Boiler Rules, and the code, which comprises the bulk of the report, and includes all of the disputed points, is what the Board of Boiler Rules is supposed to adopt after it has been legislated into existence and appointed. It would seem therefore that the work necessary before the meeting of the legislatures could be very expeditiously done. A general form of the law, not so specific as that which the committee included in its preliminary report, which is practically that of Massachusetts, but a form which can be varied to adapt itself to the usages and constitutions of the various states, should be prepared with footnotes for the guidance of legislators availing themselves of it. This should be done by a lawyer rather than an engineer, and by one having legislative experience.

If the code goes through, as apparently agreed at the hearing, all boilers will be hereafter figured on a tensile strength of 55,000 per square inch. The steel manufacturer is allowed a range of 8000 pounds, and the finished plate must be somewhere between 55,000 and 63,000, but will be stamped 55,000, whatever it may test. It is not allowed to test over 63,000, for fear of brittleness. It would appear to be a more direct and logical way to insure ductility to specify ductility and not to restrict the tensile strength, and one wonders why the designer, customer or builder of the boiler is not allowed to call for any tensile strength desired, stipulating, however, that the yield point, elasticity, ductility, etc., shall be so and so.

An analogous lack of directness appears in the specification for the filling of fusible plugs. The committee suggested "pure" tin. A critic at the hearing wished that Banca tin be specified as by the Government for the marine service. It was pointed out, however, that there is practically no tin to be procured from the Isle of Banca. The degree of purity implied by the committee's specification might be brought into question. Obviously, the logical and simple way is to specify the melting point.

A great deal of difficulty will be avoided in the introduction of the law if the factor of safety, as applied to boilers already in operation, be not placed too high. The recommendations of the committee are based largely upon Massachusetts practice. In Massachusetts, many of the boilers have been built and insured upon high factors of safety, and the allowances for pressure are more conservative than in other parts of the country, 5 and 5½ being common. In the West, however, many boilers have been accepted for insurance with a factor of safety at 4. To jump this to 5½ means the cutting down of pressure to an extent which would seriously embarrass existing industry. For new boilers the embarrassment would not be serious, and the factor of safety could be placed at any reasonable figure, but it is doubtful if there is any record of a boiler having exploded on account of a too low factor of safety, and it would appear to be the part of wisdom to put the code through with a factor which would not be onerous to existing installations, and yet would insure a sufficient margin of safety. The strict supervision of the material and workmanship which the code implies ought to insure that the boilers built in future shall be little liable to explode, unless they are grossly abused, and the safety of the boilers now in use can be better guaranteed by keeping a close inspection upon them, lowering the factor of safety in specific instances as there seems to be occasion to do so, and letting them gradually work their way out of use.

There was considerable discussion as to whether the horsepower should be based upon the heating surface or the grate surface, but it did not seem to occur to anybody that the horsepower might be dispensed with altogether to advantage. There was also considerable discussion as to safety-valve capacity. This is not a question of precision anyway; all that is required is that there shall be opening enough for the safety valve to discharge all the steam that the boiler can make under the circumstances of its installation, or any installation to which it is likely to be subjected, and it does not matter how much more is provided up to a point which cost considerations would hardly allow to be involved. And, by the way, who ever heard of a boiler explosion occasioned by too small a safety valve?

Correspondence

Boiler Gaskets

For gaskets on boilers I make a braid out of 5/8-in. asbestos wick packing long enough to fit in the groove in the manhole plate. Then I cover it well with a thick paste of cylinder oil and flake graphite. I have used this kind of gasket on the front manhole plate where the hot gases strike the plate for a year without renewing. Every time I take the plate out I put more graphite in the depression made in the gasket, and if it leaks it is because it is not thick enough or has been in use for a long time and is too hard. I think this makes a cheap gasket and easy to make. I have never had a blowout.

FRITZ E. OLSON.

Brainerd, Minn.

[Several references have been made to lead boiler gaskets in recent issues. See page 604, April 28, page 24, July 7, page 70, July 14, and page 356, Sept. 8. The care of boiler gaskets is treated on page 30, July 7.—EDITOR.]

Lost or Reversed Residual Magnetism

For a direct-current generator to reverse its polarity is an ordinary occurrence, especially with compound-wound machines used to charge storage batteries. For a generator to lose its polarity entirely, however, is unusual. Under normal conditions, the voltage due to residual magnetism will be from 5 to 15 per cent. of the rated voltage of the machine, and a voltmeter applied to the brushes will indicate this, even when the field circuit of the machine is broken. With the residual magnetism entirely gone, a voltmeter across the brushes will indicate nothing. The accompanying diagram shows a compound-wound machine connected to a battery through a switch or breaker K, which normally is closed only when the generator voltage exceeds that of the battery, in which case the current flow is in the direction indicated by the arrows.

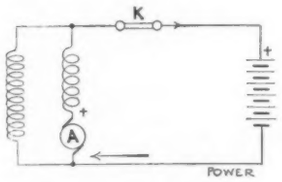


DIAGRAM OF FIELD CONNECTIONS

Should K be closed with the generator voltage slightly below that of the battery, the polarity of the generator is not likely to be reversed, because the battery will send current through the shunt coils in the existing direction, and while current does flow through the series coils in the reverse direction, the series field will not be strong enough to reverse the stronger shunt field. Should K be closed with the generator dead, however, the comparatively low impedance of the armature and series field in series will short-circuit the high impedance of the shunt winding, with the result that there will be a heavy reversed series field magnetization, with only a comparatively light shunt field magnetization to oppose it. Under these circumstances, the series field will overcome the shunt field and reverse the polarity of the residual magnetism. Therefore, the next time the shunt field picks up it will do so with the wrong polarity and the circuit-breaker will blow on closing K for charging the battery.

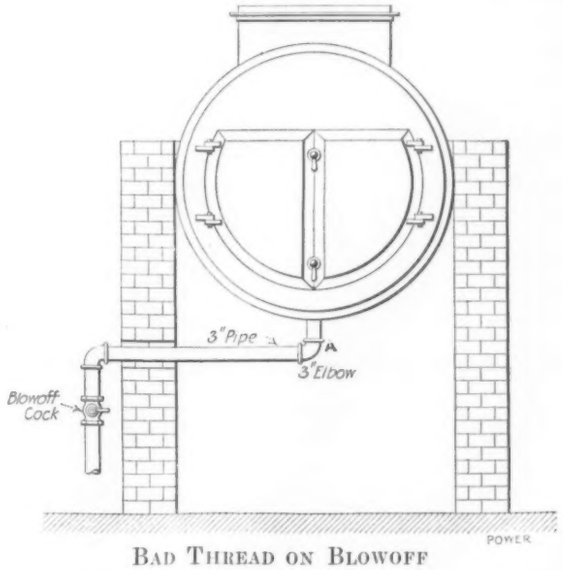
An inspector was called to a yacht to find the trouble with a gasoline-engine driven generator that would not generate. The voltmeter would not indicate when its circuit was opened and closed. Connected to a shaft extension at the commutator end of the generator was an air compressor for furnishing starting air. With the dynamo dead and the engine driving the compressor, there was considerable vibration. The inspector concluded that the dynamo, due to an ill judged closing of K, had received sufficient reverse current from the storage battery to greatly weaken the residual magnetism, and that the excessive vibration had "shaken the rest of the magnetism out." This reasoning seemed plausible, because upon lifting the dynamo brushes, so that the battery could not short-circuit through the armature, and closing K and giving the shunt field a charge from the battery, then opening K, replacing the brushes and starting the engine, the voltage came up promptly in the right direction.

J. A. HORTON.

Schenectady, N. Y.

A Case of Negligence

In a small Wisconsin manufacturing plant, where boiler inspection was none too rigid, the engineer noticed that an unusual quantity of feed water and fuel was used,



BAD THREAD ON BLOWOFF

but he investigated no further. When something went wrong with the blow-off cock, necessitating repairs, it was found in disconnecting the piping that a quarter of

a turn completely disconnected the pipe at point *A* and the thread was almost completely eaten away. There was every sign of water having leaked there at a great rate.

It is surprising that the blowoff did not fail under pressure at this weak point. Such cases should emphasize the importance of thorough inspection.

CORNELIUS WEBER.

Milwaukee, Wis.

Coke as a File Brush

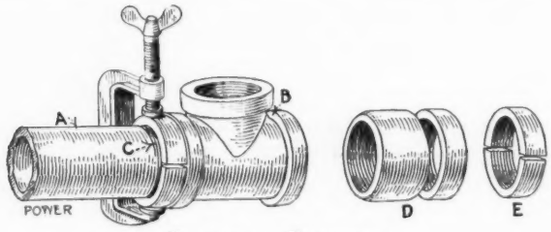
A piece of coke makes an excellent file cleaner. If it becomes full of grease when used on fine files, rub the coke on a rough file and it will become clean as well as clean the file.

C. A. FORTNEY.

Lock, Penn.

Emergency Pipe Clamp

A satisfactory form of pipe clamp is here illustrated. Pipes and nipples generally first corrode through at the threads, because there the metal is thinnest. If the pipe is not screwed all the way into the fitting, this clamp



CLAMP IN POSITION

may then be applied, no matter what the pressure is, and it will make a tight joint.

A represents a pipe screwed into fitting *B* and corroded at thread *C*. The clamp is made by sawing a ring off a coupling the size for the pipe, as at *D; E* is the ring sawed in two ready to put on. The width of the ring should be a little less than that of the thread outside the fitting. Say, if there are four threads outside, the ring should not be more than three threads wide. This will make a tight joint with a screw clamp, which is always handy in the engine room. Clamp the two half rings on the pipe with considerable pressure. If the thread on the pipe is clean, no packing is necessary except a little red or white lead. I always keep a number of these rings of different sizes on hand.

LOUIS KREUTZKAMP.

Brooklyn, N. Y.

Pump Regulators Commended

Many troubles, such as leaking feed lines, etc., are directly traceable to the practice of regulating the feed to the boilers by the speed of the feed pump.

The pump may be inefficient and regulating the speed by hand may cause the pressure in the feed line to be less than that in the boiler, consequently, if the checks should leak, the hotter water will back into the feed line, causing undue expansion strains as well as danger of water-hammer.

The remedy is to equip the pump with a governor, then, with a gage on the discharge line, the pressure can be so regulated as to have an excess pressure on the line at all times, regardless of the demand. After this, the condition of the check valve is of no consequence.

The amount of feed must then be regulated entirely by the position of the feed valve, allowing the governor to regulate the pump speed. I have known of cases where regulating the pump speed by hand has resulted in the pump becoming steam bound and causing a shutdown.

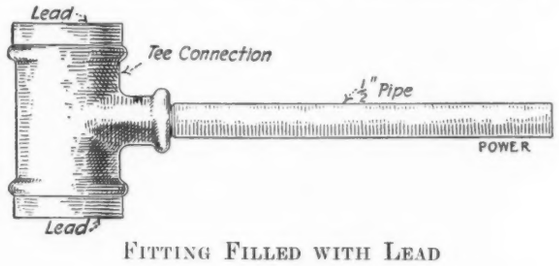
JOHN F. HURST.

Louisville, Ky.

Handy Soft Hammer

Referring to the letter by J. C. Hawkins on p. 182, Aug. 4, a soft hammer may be easily made out of a pipe fitting, as shown in the illustration.

Use a Tee with a side opening into which a pipe is screwed for a handle. Plug the pipe and use a piece



FITTING FILLED WITH LEAD

of cast iron or other scrap material for filling the greater part of the interior of the fitting, then cast the lead or babbitt metal so that there will be projecting faces at each end of the fitting.

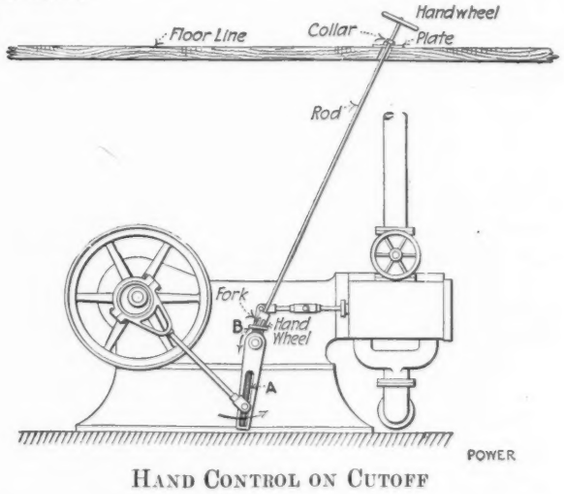
A hammer of almost any weight may be made in this way and easily recast.

F. S. WILSON.

New York City.

Remote Control for Engine

The illustration shows a remote control for blower engines, which has been in use for several years, and is a labor saver.



HAND CONTROL ON CUTOFF

These engines, which are directly connected to 24-ft. fans beneath the firing floor, are equipped with regulating

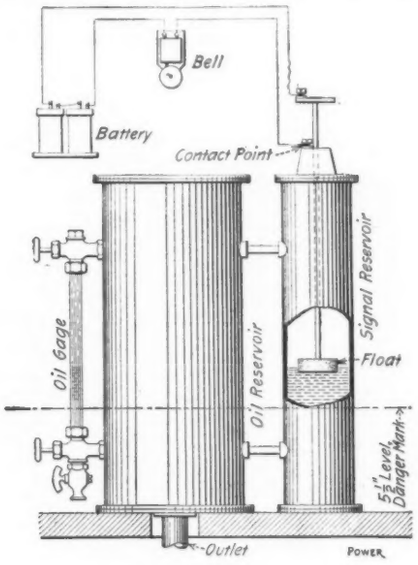
valves acting with the changes of pressure, but the extreme load variations made it necessary to secure a wide range of control.

Changes in valve travel are secured by shifting the link block up or down in the rocker-arm by means of the screw *A*, and handwheel *B*. Formerly the water tender had to go downstairs to do this. Means were devised to operate the wheel from the floor above, as shown. The total cost did not exceed $3 each.

Springfield, Ill. W. C. Cooper.

Oil Alarm on a Turbine

The Huron Cement Co., Alpena, Mich., of which the writer is chief engineer, has three times had trouble and been put to considerable expense through the damage to turbines from the splitting of a cooling tube allowing the oil to run from the reservoir into the sewer with the cooling water. As turbines are made today, there is nothing to show this danger until it is done, then it means new parts.



Low-Level Oil Alarm

To provide a warning before the mischief is done, the writer devised the oil alarm, shown in the accompanying sketch, the construction and action of which are self-explanatory. On the one side is a sight-glass indicating the level of the oil in the reservoir, and on the opposite side of the reservoir a metal cylinder connected similarly as a sight-glass containing a float on the top of the oil. A rod extending upward from this float is arranged to make an electrical contact when the oil level falls to the danger mark, and thus ring the alarm bell.

Alpena, Mich. T. S. North.

Formula for Self-Supporting Steel Stacks

The formula for the thickness of plate in self-supporting steel stacks, as presented by Mr. Durand, page 203 of the Aug. 11 issue, appears to give an unnecessarily great thickness of plate. The unit stresses of 6000 and 8000 lb. per sq.in. for single- and double-riveting, respectively, are, I believe, values of extreme conservatism. Take a stack of 10-ft. diameter and 200-ft. total height, the bell of which is 25 ft. high; the formula for single-riveting gives a thickness of plate at the junction of shaft and bell of

$$\frac{175^2}{750 \times 60} = \frac{11}{16} \textit{ in. nearly}$$

In the practical construction of self-supporting steel stacks, the thickness of the former is not over ½ in. and the latter ⅜ in. One company, extensive builders of self-supporting steel stacks, uses unit stresses for double-riveting as high as 11,000 lb. per sq.in. It would seem that with an ultimate strength of plate of 60,000 lb. per sq.in., a factor of safety of 4 and an efficiency of single-riveted joint of 55 per cent. an efficiency of double-riveted joint of 70 per cent. would satisfy all necessary requirements. This gives a unit stress for single riveting of 8250 lb and for double riveting 10,500 lb. per sq.in.

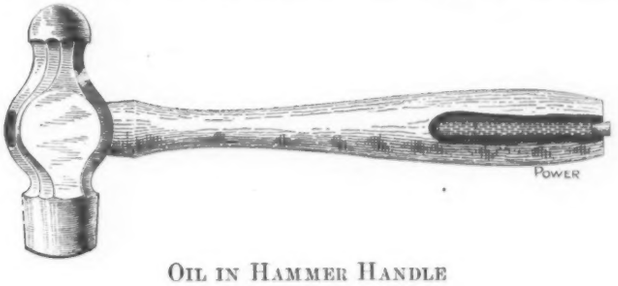
The assumption of 25 lb. per sq.in. for wind pressure is evidently a typographical error which should have read "square feet."

C. O. Sandstrom.

Kansas City, Mo.

Oil in Hammer Handles

Iron workers make a practice of drilling a hole about ¼ in. in diameter and 2½ to 3 in. deep into their hammer handles. The purpose of this is to fill the hole with oil in the belief that it prevents the handle from splitting and makes it more flexible. The illustration shows how it is done.



Oil in Hammer Handle

George J. Little.

Passaic, N. J.

Allowance for Expansion

I agree with L. Johnson, p. 179, Aug. 4, regarding keying up; even valves should be set while the engine is near the working heat. It is evident, however, that he has never had a large phosphor-bronze or gun-metal bearing run hot or he would have seen the engine slow down without the throttle being closed.

Prompt action is necessary in such cases to get it slacked back and the engine running again, thus avoiding a "freeze" and difficulty in making it leave the pin for refitting purposes. With the white-metal type of bearing, unless the engine is heavily loaded, there will be no slowing down as the metal will tear free and, if hot enough, it will throw out molten metal. In the case of a new bearing on an old pin, it will make a far better job by bedding itself by wear even if it runs a bit hot for a few days and loses a few gallons of oil.

Rochdale, England. E. R. Pearce.

Engineers' Study Course

Elementary Mechanics--XXVIII

Last Lesson's Answers

126. The linear velocity of the point N when the wheel is running at 75 r.p.m. is equal to the circumference of a circle whose radius is 5 ft., times the r.p.m. Thus, the velocity of the point $N = 2 \times 3.1416 \times 5 \times 75 =$ 2356 ft. per min., or 39.3 ft. per sec. As this velocity was acquired in 2 min., or 120 sec., the gain in velocity in feet per second per second, or the acceleration, is

$$\frac{39.3}{120} = 0.327\ ft.$$

127. (a) In last week's lesson, it was shown that the gain in velocity in revolutions per second per second was equal to the linear acceleration a, divided by the radius times 2π. Thus,

$$A = \frac{a}{2 \times \pi \times R} = \frac{0.327}{2 \times 3.1416 \times 5} = 0.0104$$

which gives the acceleration in revolutions per second per second.

This acceleration might be found in another way. Thus, the revolutions per second $= \frac{75}{60} = 1.25$, and as it required 120 sec. to attain this speed, evidently the gain in revolutions per second per second must be $\frac{1.25}{120} =$ 0.0104.

(b) All points in the wheel have the same angular acceleration, as they all pass through the same number of radians per second.

128. The weight of the wheel is the same as that of a bar 8x10 in. in cross section, and of a length equal to the circumference of a circle whose diameter is equal to the mean or average diameter of the rim. As the outside of the wheel is 12 ft. in diameter, and the rim is 8 in. thick, it follows that the mean diameter of the rim is 11 ft. 4 in. The problem now resolves itself into finding the weight of a bar of cast iron 8x10 in. in cross section and 427¼ in. long (the circumference of the circle). The cubical contents of the bar equal $8 \times 10 \times 427.25$ = 34,180 cu.in., or $\frac{34,180}{1728} = 19.78$ cu.ft. The weight of a cubic foot of cast iron is 450 lb., hence the total weight of the rim is $19.78 \times 450 = 8900$ lb.

The radius of gyration is the distance from the center of the shaft to the center of the rim, or 5 ft. 8 in.

129. A speed of 90 r.p.m. = 1.5 rev. per sec. As this speed was attained in 1½ min., or 90 sec., the gain in speed was $\frac{1.5}{90} = 0.0166$ rev. per sec. per sec. In equation (77), it was shown that $P \times d = 2 \times \pi \times \frac{W}{g} \times R^2 \times A$, or, $P = \frac{2\pi W R^2 A}{g d}$. Now in this problem the weight W is 8900 lb.; the radius of gyration R is 5 ft. 8 in., or $\frac{17}{3}$ ft.; the angular acceleration A is 0.0166 rev. per sec. per sec.; $g = 32.16$, and the moment arm d is 2 ft. Hence, substituting these values in the above equations, there results,

$$P = \frac{2 \times 3.1416 \times 8900 \times 17 \times 17 \times 0.0166}{32.16 \times 2 \times 3 \times 3} = 463.4\ lb.$$

130. The reduction in speed is (120 — 60) = 60 r.p.m., or 1 rev. per sec. As this reduction takes place in 1 min., or 60 sec., the deceleration in revolutions per second per second $= \frac{1}{60}$. The braking force P required may be found from the same equation as used in the previous problem for finding the accelerating force; thus, $P = \frac{2\pi \times W \times R^2 \times A}{g \times d}$, where $W = 8900$ lb.; $R = \frac{17}{3}$ ft.; $A = 1/60$ and $d = 1.5$ ft., therefore,

$$P = \frac{2 \times 3.1416 \times 8900 \times 17 \times 17 \times 1}{32.16 \times 1.5 \times 3 \times 3 \times 60} = 620.4\ lb.$$

Centrifugal Force

Newton's first law of motion states that all bodies continue to move in a straight line except in so far as compelled by external forces to change that path. In order that a body may move in a circle, it becomes necessary to have some constraining force applied. If a flywheel breaks, it is a matter of common experience that the parts tend to move in straight lines because the motion is no longer constrained. What force, then, is necessary to keep an object moving in a circle?

In Fig. 80, let the point A be rotating with a uniform linear velocity V about the point O. Now if the point A is to be kept moving in a circle, it must be evident

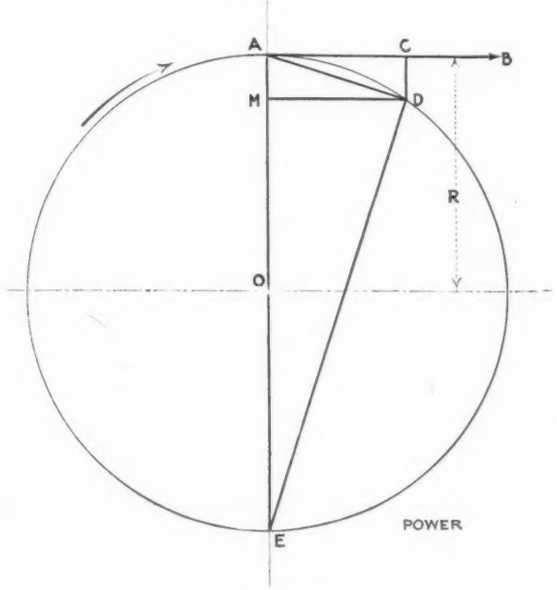


Fig. 80.

that the link OA must exert a force sufficient to hold the point A in its path. This force is called the *centripetal force*, since it tends to draw the point A toward the center O with a definite acceleration. Likewise, the force

tending to draw the body A away from the center is called the *centrifugal force*. From the conditions of equilibrium, the centripetal and the centrifugal forces must be equal and opposite to each other. If the body A were free, it would move along the line AB, and at the end of a given time would be at some point C, but instead of being at C, due to the centripetal force, the point A

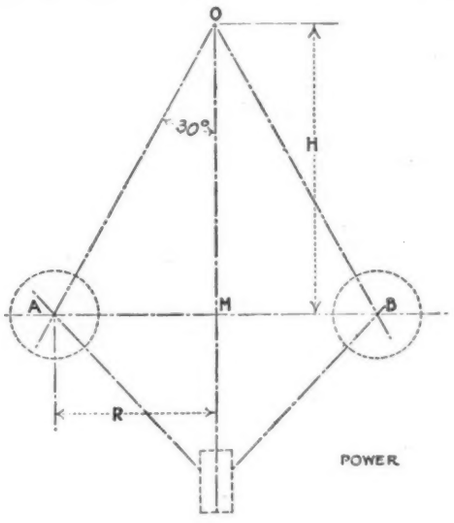


FIG. 81.

rotates about the point O and reaches some point D on the circumference of the circle Connect the points A and D with a straight line. Now if the distance AD is very small, then the arc AD and the chord AD are practically equal. Draw the line DM at right angles to AE. The distance $DC = AM$ will then represent the amount that the point A is drawn out of the path AB.

The distance AD represents the space passed over by the point A in a short interval of time, say t seconds, so that $AD = V \times t$. Now let a = the acceleration with which the point A is being drawn out of its path in a straight line. The distance AM will equal $\frac{1}{2}\ a \times t^2$ or $AM = \frac{1}{2}\ at^2$.

Draw the lines AE and DE. Then the triangles $ADMA$ and $AEDA$ will be similar, that is, they have their angles respectively equal, and as a result their sides will be proportional each to each. Thus,

$$\frac{AD}{AE} = \frac{AM}{AD}, \text{ or, } AD^2 = AM \times AE$$

From the above discussion, $AD = Vt$ and $AM = \frac{1}{2}\ at^2$, and as AE is the diameter of the circle, it must equal $2\ R$. Now, substituting these values in the above equation, there results

$$V^2\ t^2 = \tfrac{1}{2}\ at^2 \times 2 \times R, \text{ or}$$
$$V^2 = a \times R, \text{ and}$$
$$a = \frac{V^2}{R} \qquad (78)$$

That is the acceleration with which the given point A is drawn out of its path in a straight line by the force acting in the link OA is $\frac{V^2}{R}$, and from equation (49) $F = \frac{W}{g}\ a$. Therefore, let C = the centripetal force exerted by the link OA to keep the point A moving at a distance R from the point O, then

$$C = \frac{W}{g} \times a = \frac{W \times V^2}{g\ R} \qquad (79)$$

This same equation may be used to figure the centrifugal force exerted by rotating bodies. The existence of this force accounts for the fact that all large rotating bodies, such as flywheels, must be carefully balanced, otherwise there will be an excessive pressure exerted on the bearings supporting the rotating body. Likewise, the crank pins and part of the connecting-rods of engines must be balanced. This may be done in various ways. Where crank disks are used, one end is made much heavier than the other. In locomotives, additional weight is added on the side of the driver opposite to that containing the crankpin. This is called the counterweight or counterbalance.

Equation (79) may be expressed directly in terms of the revolutions per minute, N, made by the wheel. Since the linear velocity $V = \frac{2\ \pi\ R\ N}{60}$ feet per second, it follows that

$$C = \frac{W\ V^2}{g\ R} = \frac{W \times (2\ \pi)^2 \times R^2 \times N^2}{60^2 \times g \times R} = \frac{(2\ \pi)^2\ W\ R\ N^2}{3600 \times g}$$

Or

$$C = 0.000341\ WRN^2 \qquad (80)$$

STUDY QUESTIONS

131. A flywheel 10 ft. in diameter is running at 100 r.p.m Find the acceleration with which a point on the rim is moving toward the center of the wheel.

132. If the face of the wheel is 10 in. and the thickness of the rim 8 in., what is the centrifugal force per inch length of rim?

133. A wheel running at 1500 r.p.m. has an unbalanced weight of 5 lb. at a distance of 18 in. from the center. Find the pressure in pounds on the bearings due to this unbalanced weight.

134. Fig. 81 is a diagrammatic sketch of Fig. 14, Lesson IV. If the link OA is 18 in. long, find the r.p.m. of the ball A when the link makes an angle of 30 deg. with the vertical.

135. What decrease in speed must take place so that the angle OAM will be reduced to 20 deg.?

Longest Transmission Line

Officials of the Nevada-California Power Co. announce the completion of the company's transmission line from the plant of the Southern Sierra Power Co.

Power is now carried over the new line from the generating plant in the Sierra Nevada mountains near Bishop to El Centro in the Imperial Valley, a distance of more than 400 miles. This is the longest power line in the world being almost twice as long as the transmission line of the Pacific Light & Power Co., to Los Angeles. At the opening the new line carried 2000 hp. of electric energy. It has a capacity of 10,000 hp.

There are four substations on the new line, at Banning, Coachella, Caliptria, and El Centro and each of these will be a nucleus of a distributing system. There are four power plants in Imperial Valley, but these were unable to supply the demand and arrangements were made for a supply of power from Southern Sierra Power Co.

The greater part of the power transmission over the new line will be used for irrigation pumping. Underneath the Imperial Valley lie inexhaustible supplies of water, which must be pumped to the top of the ground to be available.

The Southern Sierra Power Co. is controlled by the Nevada-California Power Co., and owns two hydro-electric plants, with a steam generating plant at San Bernardino. Its lines are connected with those of the Nevada-California Power Co., which owns a development of 35,000 hp., the two companies being operated as one.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

We feel proud of the kind reception given our little daily, the "Power Pup," at the N. A. S. E. Milwaukee convention. Of course, its success was made possible only by the hearty support accorded it by both engineers and exhibitors. We thank them, one and all.

How a boiler manufacturer can find time to make boilers as well as jokes, let alone spread 'em broadcast (meaning the jokes) is beyond our ken. The twenty-sixth annual convention of the American Boiler Manufacturers did it at the Waldorf-Astoria, New York, recently. What else they did is something else again, but they're sure a happy lot, considering the nature of their business.

The motive power of an East Indian fan, the punkah, is the wallah, who operates it for $2.60 a month. But the enterprising Occidental is introducing the electric fan, putting the punk in the punkah and a wall around the wallah. This is what they call "palliating the fierce heat of the tropics."

Time approaches for the annual awarding of those forty-thousand-dollar Nobel prizes. While this is a neat little bunch of money, the attending publicity of the thing makes some of us modest uplifters hesitate.

No, sirree! not one word about the war. We are a neutral people, a peaceful country. Any more suggestions from our correspondent at Milwaukee and we'll refer him to Dick Foley, and—"Out the window he must go!"

President Wilson favors slicing twenty-five millions off the rivers and harbors appropriations. This slicing is evidently aimed, not at our water-power developments, but at Congressman Porkbarrel, who would make navigable his farm and those of his neighbors.

Somebody says that being a boy is a matter of temperament rather than age. Surroundings have something to do with it. We've known young men in archeological plants who looked like Pharaoh's granddad, and whiteheaded boys of fifty in a real plant who just radiated sunshine and kindliness; they'd make Sunny Jim look like a professional pallbearer.

MAN AS AN ELECTRIC CURRENT

BY F. W. SWIFT

Man can be compared to an Electric Current in many ways. He has to undergo a Series of Ups and Downs from the time he first enters this world until he leaves it.

If he has a large Capacity for directing his Energy in the right Line, he is going to be a Leading Power Factor in his community; if he allows himself to be Induced by others, he will be found Lagging.

He must get into Synchronism with his fellow workers—i.e., keep In Step with them when they are all directing their Energy for their employers' welfare. Personal Magnetism is the Exciter of the esteem and admiration of his employers and his fellows.

He must be able to Transform his Energy into whatever Phase of work he is, by circumstance, Transmitting, and so Distribute his Energy that his best service is obtained. His ability to overcome Resistances in his path depends upon the Pressure his mind and backbone exert.

The Frequency with which he studies Current affairs will show up sooner or later. Some men display much Reluctance toward the Admittance of new ideas into their Storage Cells and will not "Do it Electrically"; for such, a Ground!

His great Prime Mover is ambition. It Generates in him sufficient Power to do Watt he has to do, and his Efficiency is greatly augmented if he does not divert his Power in Generating Stray Current and—Exciting himself over small mishaps.

Electric Current is valuable for the work it does and the effects it produces, if it is available when needed. So also with man, who must be on the job in Readiness to Serve; if not, he will fall Flat at a quick Rate.

Care of Machinery and Tools

In visiting power plants, one sees little things that seem wrong, and perhaps similar ones in his own plant after returning.

For instance, bearing keys and wedges with battered ends look bad and sometimes cause trouble when the key is to be taken out; it could have been avoided if a soft hammer had been used. This also applies to Corliss-valve stem keys, which are frequently found battered. As a rule, small cylinder heads and valve bonnets have no eye-bolt holes, and in order to remove them it is necessary to use a chisel; this mars the edges. Eye-bolt holes should be provided, into which setscrews may be screwed to start the joint, and when the head is in place short nickel-plated capscrews may be put in the holes.

The square of the filling plug on the cylinder lubricators and the bonnets of brass valves are many times seen with the corners rounded off by using a pipe wrench or pliers to loosen them. Instead of a pipe wrench, use either a monkey wrench which will not spring, or an open-end wrench. If the plug leaks, put a lead gasket on the seat. While the first cost is a little more, lubricators should be nickel-plated, because they will always look clean if given a little attention and will not tarnish like the plain brass.

One frequently sees a wrench which is badly battered up from hammering on the end of the handle. Instead, why not slip a short piece of pipe on the handle? The nut can then be drawn up as tightly as desired. This, however, should not be overdone, or the bolt will be broken or the wrench ruined.

Another misused tool is the monkey wrench. It should not be used where a great strain is required, nor as a hammer. See that it fits the nut closely, and never use a pipe on its handle.

The Stilson and Trimo pipe wrenches are also much misused. Although they are made very heavy to withstand the hard usage, how many times we see them with the handles badly bent, showing that the size was too small or that there was a piece of pipe on the handle to give additional leverage.

Sometimes hand oil-can spouts are so badly battered that the oil squirts out at the side seam instead of at the end. Another eyesore is an overfull cylinder-oil pot setting on the engine or pump cylinder, the oil running down the side of the cylinder, presenting a slovenly appearance and being wasted. Greasy waste scattered about looks untidy, and is sometimes dangerous as it may catch fire or get into the machinery and cause trouble.

Every tool not in use should be cleaned up and put in its proper place, where it may be easily found when wanted. This, however, is not always done, and no one notices it sooner than the stranger.

These are some of the things which attract the attention of the visitor or the employer. Of course, they are not to be seen in our own plant, but anyone who visits around will notice them in the other man's plant. Perhaps it would be a good idea to look around tomorrow and see what you can find in those dark corners.

Weight and Bulk of Coal—The average weight of one cubic foot of solid coal is 87½ lb. The average weight of one cubic foot of heaped coal 51¾ lbs. One ton of coal occupies approximately 43½ cu.ft.

Uniform License and Boiler Laws

Several years ago, there was appointed by the Council of the American Society of Mechanical Engineers, in accordance with a resolution adopted at a regular meeting of that society, a committee to formulate standard specifications for the construction of steam boilers and other pressure vessels, and for the care of the same in service. John A. Stevens, consulting engineer, of Lowell, Mass., at that time a member of the Massachusetts Board of Boiler Rules, was selected as chairman, the remaining members of the committee being William H. Boehm, in charge of the boiler and flywheel departments of the Fidelity & Casualty Insurance Co.; Prof. R. C. Carpenter, of Sibley College; Richard Hammond, president of the Lake Erie Engineering Works; Dr. Charles L. Huston, vice-president and works manager of the Lukens Iron & Steel Co., and of the Jacobs-Shupert U. S. Fire Box Co.; E. D. Meier, past-president of the society and president of the Heine Safety Boiler Co., and Prof. E. F. Miller, of the Massachusetts Institute of Technology.

In February of this year, this committee issued a tentative report of 238 pages, comprising a suggested form of engineers' examination and license law, a boiler-inspection law and a code of rules for the construction and installation of boilers and other pressure vessels, for the use of the Boards of Boiler Control for which the suggested boiler inspection law calls. Some 1500 copies of this tentative report were issued to recognized authorities throughout the civilized world, including nonmembers of the society as well as members, and comprising boiler manufacturers, steel manufacturers, insurance companies, boiler users, consulting engineers, operating engineers and all who have special knowledge of the boiler business. Each was requested to study the report carefully and to give the committee the benefit of his knowledge, to the end that a model form of law and a code which would insure the best design, construction, installation and operation of steam boilers might be evolved through their collective wisdom and effort.

This report was briefly discussed at the St. Paul meeting of the society in June, and it was there voted that the committee should hold in the rooms of the American Society of Mechanical Engineers, 29 West 39th St., New York, a hearing of all interests concerned, on Tuesday, Sept. 15. The hearing thus provided for was called to order in the forenoon of Tuesday, Sept. 15, by Chairman Stevens, all of the members, with the exception of Col. Meier, being present. The occasion brought together between 100 and 200 engineers and manufacturers, boiler inspectors, officers of boiler insurance companies and others vitally interested in the questions involved.

HISTORY AND NECESSITY FOR UNIFORMITY

Mr. Stevens opened the meeting with a brief and forcible presentation of the history and necessity for the work which the committee has undertaken. In this country, since 1867, 46 years, there have been 10,051 people killed and 15,634 injured in boiler explosions which have found their way upon the records. In 1913, there were 499 explosions, with 180 killed and 369 seriously injured. The Massachusetts law was not brought into existence by the Brockton explosion, which cost 56 lives and $552,000, nor by the closely following Lynn explosion, but because the capitalists had something to say in Massachusetts. He had represented them upon the Massachusetts Board of Boiler Rules, and they insisted that they should have a set of rules which would avoid losses of this kind, and that they be uniformly enforced. There were also thousands of operatives who put in their time over and around boilers. In Connecticut there was an explosion of a boiler, directly over which 50 girls had been working 20 minutes before. There is a boiler under one of the $1,000,000 hotels of New York which would not be tolerated within the confines of Massachusetts. For 10 to 20 per cent. additional cost, you can have boilers which are safe, and if you examine and certify the men who are put in charge of them, you will go a long way toward wiping out this blot on American industry, and of carrying out the idea of "Safety First" which has taken so strong a hold upon the people.

Edward H. Wells, president of the Babcock & Wilcox Co., said that his company was in hearty accord with the effort which is being made to establish a standard specification for steam boilers. They believe in it, first, because they hope it may lead to the building of better and safer boilers; second, because they hope there may be established here a standard specification that shall be the pattern upon which 45 or 46 states which have not already acted shall base the laws which they are determined to pass governing the manufacture and use of steam boilers. If out of the deliberations of this committee there shall come a set of specifications and rules for the building of boilers which may be incorporated into the laws of the states of the Union, every manufacturer of boilers and of material which enters into the construction of steam boilers will have gained a very considerable advantage.

WIDE INTEREST OF STATE LEGISLATORS

Thomas E. Durban, general manager of the Erie City Iron Works, said that the concerns which he represented have been interested in this subject for something like six years. They were driven into it from the fact that they manufacture all types of boilers, and are confronted with all kinds of laws in the various states. It is impossible to build a boiler which will conform with the laws of all the states and municipalities where it is likely to be used. This condition became so onerous to the builders of shell boilers that they had formed an organization for the purpose of advocating the adoption by the various states of uniform legislation, and, without knowing what the committee of the American Society of Mechanical Engineers was doing, had held several meetings, were in correspondence with the governors of 19 states who were awaiting only the completion of a standard form of law to recommend it for passage by their legislatures. When the work of this committee came out in the spring, they fell into hearty accord with it, and were now awaiting only their final report to adopt it as a basis of their promulgation work. There never was a more propitious time to urge the passage of such legislation, and there is no better subject for legislation to put before the legislators. In our factories, we are obliged to protect the gears, we have to protect the elevators, all the buildings must have fire-escapes in order to meet the requirements of the Safety-First movement, yet, as Mr. Stevens has pointed out, it is possible now, in many of the states where this Safety-First movement has been working, for a man to put up an elegant building provided with every possible safety device, and yet to have in the basement of that building a boiler that may devastate the entire structure. The boiler manufacturers recognize their responsibility in the matter. It means a radical change in the process of manufacture to a great many people, and yet among all the boiler-making fraternity he did not believe there was a single man who had objected to the movement. But uniformity is an absolute necessity in putting work through the shop. If it has to meet the requirements of an Ohio law, an Indiana law, a New York law and a Pennsylvania law, that differ in one simple detail, it is almost impossible, with the variety of boilers and the different types of boilers, to put them through the shop and have them come out right. There is also to be considered the man who is in an occupation, as, for instance, a building contractor who has different engines for each state in which he makes a contract. The agricultural-engine people who build their boilers for threshing purposes will have to have a different boiler for different states. It not only makes it inconvenient for the manufacturers, but it is a needless waste of money to the purchaser. The boiler makers stand here willing to accept anything that is right, regardless of small technicalities, so long as we can get uniformity. The time is ripe for this kind of legislation. We must not put it off. If we can make a recommendation close to the existing laws, and if we can get five states, or even three states, of prominence to adopt the recommendations of this society, it will be a perfectly natural outcome that the other states will do the same thing.

Mr. Connolly, of Cleveland, said that the American Boiler Manufacturers' Association, representing about 90 boiler manufacturers, has in view the same thing that Mr. Stevens and Messrs. Wells and Durban have urged, the protection of life and property. The three essentials to this are good materials, good workmanship and an operator who understands the operating of a steam plant. He would like to see the rules as concise as possible, and recommended that particular attention be paid to the phraseology, so that there need not be developed a lot of boiler lawyers to tell what the law means after it is passed.

Mr. Broderick also spoke for the American Boiler Manufacturers' Association, putting in a strong plea for a uniform law. He came from Indiana, and said that that state had the poorest boiler law of any in the union.*

C. S. Blake, secretary of the Hartford Steam Boiler Inspection & Insurance Co., said that his company has always advocated proper laws regarding the licensing of engineers

*See "The Indiana Boiler Law," in the issue of Aug. 25, page 277.

and the construction of boilers. It was influential in framing the Philadelphia ordinance, nearly 50 years old, and has always been glad to give its help and advice to states and municipalities in framing laws. Any position contrary to that would be in contradiction to the claim which they have always made of being the first company to insure safety.

N. A. S. E. READY TO COÖPERATE

Joseph Carney, superintendent of the McAlpin Hotel, and representing at the hearing the National Association of Stationary Engineers, of which he is a past-president, spoke from the point of view of the users of boilers. He said that he was deputized by that society to convey to the committee its deep interest in the work which they had undertaken, and its readiness to coöperate to the full In introducing Mr. Carney, as well as during the previous discussion of the tentative report at the St. Paul meeting, Mr. Stevens gave the National Association of Stationary Engineers very complimentary credit for the persistent effort which that association had made, almost single-handed, for license and boiler inspection laws, and Mr. Carney, in acknowledging this compliment, expressed the pleasure of the body which he represented to find that the great American Society of Mechanical Engineers at work on the same line that they had pursued in their crude way for so many years, and trusted that much good would result. Past National President James Coe spoke also for the State Association. Dr. Alexander C. Humphrey, past-president of the society and president of the Stevens Institute of Technology, advised the committee against undue haste, and reminded them that any act of theirs would be accepted as an act of the society. He said that there were important interests which had not been consulted, and hoped that every available source of information would be sought, and everybody whose interest was affected would be permitted to have a say before the report of the committee was finally put before the society.

E. T. Child, representing the Association of Master Steam and Hot-Water Fitters, assured the committee of the hearty sympathy of that society with its efforts.

LIGHTING AND TRACTION INTERESTS URGE UNIFORMITY

I. E. Moultrop, of the Edison Electric Co., of Boston, said that the interest with which he is connected uses a large proportion of the boilers in use in this country, and it would be a great benefit to them, as boiler users, to have a standard to which all boiler manufacturers should live up. Anything that this committee could do to bring about that condition would be of real benefit, but they ought not to push it through too rapidly and subject themselves to the criticism that all interests had not been heard. He suggested that the Association of the Edison companies, the National Electric Light Association, the American Street Railway Association and the railroad organizations ought to have a hand in the matter.

Edwin D. Katte, chief engineer of electric traction, New York Central & Hudson River R.R., and chairman of the committee on railroads of the American Society, assured the committee that the railroads were among the largest users, even of stationary boilers, and that his committee had much to impress upon them if they were afforded the opportunity.

Edgar Marburg, secretary of the American Society for Testing Materials, made a persistent effort to get himself and the representatives of his society upon the committee as voting members. They would not give the committee the benefit of their knowledge of the subject upon any other condition. They refused to be put up as witnesses to be cross-examined, and without the privilege of bringing in a minority report, but insisted upon sitting upon the bench. His insistence upon this point, with the intimation that others might insist upon a like representation, created some confusion in the forenoon session. At the commencement of the afternoon session, however, the committee announced its intention to hear everybody who had sent in a written discussion first, persons who had not presented a written discussion directly after, or at a hearing to be arranged later; that another public hearing or hearings should be held, if the results of this hearing demonstrate the need thereof, and that the committee would meet in conference with any interested body and give the representatives of that body opportunities for full discussion and consideration of every question involved by the report. Proceeding in this line, the committee succeeded in reconciling its differences with the steel manufacturers, the railroad and the other interests, and avoided a criticism of not having had the coöperation of the American Society for Testing Materials by adopting the code of that society, with a few unimportant modifications, so that as the hearing adjourned, there appeared to be a substantial agreement upon a code which will insure, as the chairman expressed it, a little better material than we have been accustomed to having, correctly designed, honestly constructed and properly operated boilers, and a material reduction in the number of accidents resulting from their misuse.

POINTS RAISED FOR CONSIDERATION

Some of the points raised for consideration were:

The possibility of making the engineers' license universal by providing that the license of one state should be accepted in another when approved by the inspector of the latter state

Instead of exempting locomotive boilers generally, exempt only those which are under the jurisdiction of the United States Government. This would bring under state inspection the locomotives of private companies, and drill engines, etc., used by the railroads; everything, in fact, not inspected by the Federal authorities.

What about locomotive cranes and pile drivers, and dismantled locomotives used in stationary service? Should the age of such boilers, as affecting the factor of safety, be reckoned from the date when they were first made, or the date when they became stationary boilers, in view of the fact that they are at that time largely made over?

Should boilers built for shipment out of the state be exempt from inspection while building, which is the only chance to observe compliance with the rules? If inspected during construction, should the inspection be by the state in which they are built, or by the state into which they are going? If the latter, what about stock boilers, portable boilers and boilers having no definite destination?

The tentative rules provide that every insurance company authorized to inspect and insure boilers and pressure vessels shall have in its employ at least one inspector who resides in the state. Mr. Blake pointed out that the total business of all the companies insuring boilers did not amount to enough in states like Idaho, Wyoming, etc., to support a resident inspector. It would affect his company less than the smaller companies, but it was unjust to all. The tentative rules provide that inspectors of boiler-insurance companies shall be examined by a board consisting of three members of the State Boiler Department. These are drawn from the same rank and plane, with the same degree of education, as the candidate. Mr. Blake thought that it would be better to provide a board with greater experience in examinations, and in gaging and testing men for competency. In Ohio they had improved upon the Massachusetts law by requiring a written examination. Mr. Blake further pointed out that the Massachusetts rules provide that if a man retires voluntarily from the service of one company, he cannot serve as inspector for another until he takes a new examination. On the other hand, the rules provide that a man cannot take another examination inside of 90 days. Two years ago, one of the companies operating in Massachusetts went out of the boiler business, and their inspector, who had passed his examination shortly before, was out of a job for three months. A man once licensed should always be licensed.

It was suggested that the serial number applied by the boiler manufacturer to the boiler when made should be accepted by all the states that the boiler may be used in, and that a boiler inspected and passed in one state should be adjudged good in another.

A suggestion was made that fusible plugs be required to be filled with pure Banca tin, instead of the "pure" tin of the committee's suggestion. The railroad men were in favor of doing away with the fusible plug altogether, the marine men were strong for it, and most of the stationary men preferred that it should be required. It was pointed out that tin from the island of Banca is no longer procurable in large quantities, and that the degree of purity implied by the committee's suggestion might be called into question. The best suggestion made was that the melting point be specified. Mr. Olshausen, of the Bureau of Standards, suggested that there was such a thing as tin disease; the metal changed its nature and its melting point; and he suggested that the whole subject be referred to the Bureau of Standards.

The provision for putting the law into operation should be such as to adapt itself to states in which there is already some sort of inspection; otherwise, political and other opposition may be incited. The legal part of the document is largely paraphrased from the Massachusetts law, and it will be necessary to have this portion of the report reviewed by a lawyer before it is finally presented.

Prof. Gaetano Lanza, of the Baldwin Locomotive Works, pointed out that the rule for the maximum allowable pressure, which in the report is the formula ordinarily in use, attempts to determine the strength of the weakest plate by coupling with the diameter of one plate the thickness of another. The strength of each plate should be based upon its own diameter and its own thickness.

LOWEST FACTOR OF SAFETY

In the tentative report, the lowest factor of safety to be used for boilers, the longitudinal points of which are of butt

and double-strap construction, is 4.5. Prof. Lanza says that the use of a factor of safety of 4 has been and is very widespread, and has been adopted by many authorities which prescribe laws for the construction of boilers, including the Interstate Commerce Commission in America and a number of boards in England. Seaton, on page 443 of his treatise on Marine Engineering, edition of 1907, says:

"The board requires a minimum factor of safety of 4.5, while the Admiralty is content with 4, which is quite sufficient, considering the stress on the material is gently applied and quite a steady one during work." The size of safety valve required should be based on the amount of heating surface instead of the grate area. In the light of a series of experiments made, a committee of the Railway Master Mechanics Association decided that in order to relieve the boiler, the discharge of the safety valve should be 4.1 lb. of steam per hr. per sq.ft. of heating surface.

SHEARING STRENGTH

The results of such experiments as he, Prof. Lanza, had in mind would lead him to place the shearing strength of steel rivets in single shear at about 44,000 or 45,000. The Interstate Commerce Commission advocates 44,000, and many bodies which make rules for boiler construction prescribe 44,000 or 45,000. He was not aware of any experimental evidence that would warrant the use of a smaller value of shearing strength in double shear than in single shear, meaning by this that a rivet in double shear ought to be credited with both sections sheared or have a value of twice the single shear.

BOILER RATINGS

The tentative rules provide that a boiler having 1 sq.ft. of grate surface shall be rated at 3 hp., when the safety valve is set to blow at over 15 lb. per sq.in., and a boiler having 2 sq.ft. of grate surface shall be rated at 3 hp. when the safety valve is set to blow at 15 lb. per sq.in. or less, evidently meaning that such boilers ought to be rated with the respective amounts of horsepower for each one or two square feet of grate surface. Prof. Lanza pointed out that this was not in accord with the standard adopted many years ago by the American Society of Mechanical Engineers.

The moment of inertia of an angle or a "T" is not correctly expressed by the formula $\frac{bh^2}{12}$.

In calculating the area to be stayed in such surfaces as the heads of horizontal return-tubular boilers, an arbitrary allowance of 3 in. from the flange is not suitable for all cases; sometimes more and sometimes less would be proper.

C. D. Young, testing engineer for the Pennsylvania R.R., did not believe a minimum factor of safety of 4.5 proper for all cases of stationary boilers. There should be some variation in the factor of safety, depending upon the service, pressure and maintenance to which the boiler has been subjected. He did not believe that any definite proof could be shown, where any boiler had exploded because it had a factor of safety as low as 4. When the diameter of the rivet holes in the longitudinal seam of a boiler is not known, one of the rivets should be removed in order to measure the diameter of the hole, and if impossible to fill the hole with a new rivet, the hole should be tapped and a tap bolt applied. In his opinion, the size of safety valve should be based on the heating surface.

S. F. Jeter said that in Massachusetts the factor of safety incorporated in the proposed rules was adopted five, six or seven years ago. In that state, conditions were different from those in the United States generally. The boilers were operating under a high factor of safety, and pressures were somewhat conservative. The majority of the boilers in the United States are now operating on a factor of safety of something over 4, and many on a factor of 4, and, if you attempt to apply a greater factor to boilers already in use you are going to meet tremendous opposition from the owner. The adoption of a factor of safety of 5.5 would seriously affect probably 60 to 75 per cent. of the boilers in use, and he believes it will be absolutely impossible to enforce such a law. The Ohio law is much superior to Massachusetts in this respect.

C. D. Young said that the ultimate allowable shearing strength for iron rivets in double shear should be double that for single shear, or 76,000 lb. per sq.in., as corroborated by recent tests on rivets in single and double shear. The proposed law provides for steel rivets to have a strength in single shear of 42,000 lb. and in double shear of 78,000 lb. He believes these figures should be raised to 44,000 and 88,000 lb., respectively. He has a record of a large number of tests made under his jurisdiction in the test department of the Pennsylvania R.R., which shows that steel will give a shearing strength above the figures quoted. The Federal Government has recognized these figures in the maximum shearing strength, under the regulation of the Interstate Commerce Commission.

The clause relating to maximum pressure should be worded to permit the use of cast iron for malleable headers if superheated steam is used, as it is good practice for pressures above 125 lb. He has had a great deal of experience with cast-iron superheater headers used on pressures as high as 205 lb., and found them entirely satisfactory. The character of the superheater header cannot in any way be a dangerous element to the operation of a boiler. C. A. Anstrom favored extending the life of lap seam return-tubular boilers to 25 years.

Mr. Kruesi, of the General Electric Co., objected to the age limit specified in the rules for factors of safety, as it would put out of commission many boilers in good condition.

Mr. Young objected to the sliding scale for factors of safety. To boilers properly maintained, the sliding scale need not apply, and under such conditions the age should not increase the factor of safety required. Mr. Boehm, of the committee, asked: "Suppose a boiler has a weak head, and it had been breathing more than usual and fatigue had taken place? Would you not discuss a factor of safety then?" Mr. Young replied that if the committee had any evidence to indicate that any trouble had occurred, this might be done, but to make the rule cover all cases where the design has been proper and the maintenance good did not seem necessary.

POP SAFETY VALVES

A. J. Schoff objected to the rule requiring pop safety valves, and suggested that the lever safety valve be allowed. He said that they have 300 of them, which have beeen used for 30 years. The government made them put a pop safety valve on one; they had all kinds of trouble and had to go back to the government and get it changed back to a lever valve.

A. D. Carhart, superintendent of the Crosby Steam Gage & Valve Co., thought that Mr. Schoff gave an erroneous impression in making it appear that lever safety valves are superior to the pop type. The government had limited experience, and it continued the use of lever valves, but did not allow them on new installations. He thought it a hardship to require two safety valves on all boilers. It was a good thing, but might be a hardship on small boilers under 15 lb. pressure. When a boiler requires a valve less than 2½ in. in diameter, it would be too bad to make them split it into two valves. In the case of valves of larger diameter, it is all right, and is less strain on the boiler. He thought that the heating surface instead of the grate surface was the logical factor for determining the area of the safety valve, but had withdrawn his active advocacy of that practice because of the number of advantages and workable features of a proper rule based on the grate surface.

L. M. Brigham, of the Consolidated Safety Valve Co., objected to the general formula for a safety valve proposed by the committee, because it does not take into account the lift of the valve, and suggested an entire modification of the safety valve requirements. F. C. Blanchard, speaking for Mr. Brigham, said that their company and other leading safety-valve manufacturing companies had made tests of valves from different manufacturers; the lifts are found to vary in the neighborhood of 300 per cent., some having three times the lift of others of the same diameter and built by the same concern. The proposed rule and the Massachusetts and other rules assume that the lift must be $\frac{1}{24}$ of the valve diameter; in other words, a valve 4 in. in diameter is assumed to have a lift of ⅛ in. to pass the steam which the rules specify. There are velves on the market that will not do that. He believes this is an opportunity for the board to make a rule which is logical, and to base it on the evaporation and the actual valve capacity. The Master Mechanics Association, representing the railroads of the country, made a rule two years ago in which it took the lift into account. He recommended that the accumulation test be made a portion of the rule. It consists in shutting off all possible exits of steam. The boiler is then run to its full capacity, and if the pressure in the boiler runs up 15 per cent. over the pressure for which the safety-valve equipment is set, it is considered inadequate.

Mr. Crosby said that we have a million boilers probably in this country, and if you undertake to tell them all to put on two safety valves there will be trouble.

Prof. Jacobus called attention to the fact that there were a number of boilers, such as waste-heat and other types, which do not have any grates at all upon which the size of the safety valve could be based. There are a number of boilers in the city which are run from 300 to 400 per cent. of rating. There you must have provision for taking care of an enormous amount of steam in case of a sudden shut-

down of the engine. As far as he knew, the only way to get at it was to know the maximum steam-making capacity of the boiler, and provide safety-valve capacity to take care of it.

Prof. Miller, of the committee, said that they had been holding back on the safety-valve question, thinking that the research committee on safety valves which the society had in the field would be able to report in time for this committee to use the information. Such things as having the safety valves marked with the discharge capacity have been considered. A valve with a high discharge opening may give a hard, pounding action when the valve seats. He thought the best satisfaction came from the use of valves with small lifts. Unless the lift of the valve is marked upon it, it would be impossible to tell the discharge capacity, and even then the resetting of the valve by the engineer may alter the lift or discharge capacity quite a little.

Mr. Blake said that Philadelphia has for many years required two safety valves on all boilers installed within its jurisdiction.

Mr. Carhart urged that the safety valve be directly upon the boiler, and not upon a connection.

Prof. Jacobus said that safety valves should be placed on the outlet of superheaters, and not on the inlet, the idea being that if the flow of steam is suddenly checked the superheater becomes filled with steam not in contact with water, and there is nothing to limit the temperature to which the steam may be carried. If the safety valve is on the outlet of the heater, the application of heat will raise the pressure, the safety valve will blow, and the temperature cut down within safe limits.*

Mr. Stevens explained that the rule was made to protect the safety valve. At the inlet it would be subjected only to saturated steam, and under all conditions of temperature would be in active order. Prof. Jacobus said that he would put a valve on the outlet and omit it on the inlet, but have it designed to stand superheated steam with an outside spring. Mr. Carhart, being a maker of pop valves, raised a laugh by recommending that valves be used on both inlet and outlet. Prof. Jacobus said that it would be hard in some constructions to get a safety valve on the inlet of the superheater, and so far as the idea of having a superheater explode from the pressure due to a slug of water, he had tried the experiment a number of times, and the amount of back pressure to be got in that way is not dangerous.

The chairman asked if this would apply to independently fired superheaters, and Prof. Jacobus replied that the two valves would be all right there. On an independently fired superheater, it would be well to have them on the inlet and outlet, but on the outside only on the connected superheater

Mr. R. D. Yarnell recommended that nonreturn valves be used in every boiler installation.

CHEMICAL LIMITS OF BOILER STEEL

The tentative rules of the committee gave as the chemical limits of the steel to be used in boiler construction manganese, 0.30 to 0.50 per cent.; phosphorus, 0.03 per cent. maximum; sulphur, 0.03 per cent. maximum. These figures were vigorously combatted by the steel manufacturers, with the result that they were modified to 0.035 per cent. maximum so far as the phosphorus and sulphur are concerned. All firebox steel is to have a tensile strength between 55,000 and 63,000 lb., but to be stamped 55,000, and both firebox and flange grades may be used.

Conferences were held with the steel manufacturers, tube manufacturers, and the draft of rules revised, as above stated, and so as to allow charcoal iron and lap welded tubes. We may discuss some of the provisions further in a later issue.

Salmon River Development to be Enlarged — Organized chiefly by Spokane, Wash., contractors, the Salmon River Light & Power Co. has sold bonds in the amount of $125,000 to the Spokane & Eastern Trust Co., and is starting plans for the enlargement of the hydro-electric development of the Salmon river in Lemhi County, Idaho. The trust company has already resold $100,000 of the bonds to Spokane investors. The issue is in 10 year serial bonds bearing 6 per cent. interest. The company was recently incorporated and has taken over the Lemhi Power Co. which was successfully operated for several years, supplying light and power to the town of Salmon Idaho. The new corporation will start at once the construction of a new power plant, including a dam across the Salmon River, designed to have a capacity of 3000 hp.

*See "Power, Jan. 27, 1914, pp. 130-132.

Some Features of the Electrical Exposition and Motor Show

For the purpose of showing how important a part electricity plays in modern warfare, the army and navy of the United States are arranging a series of special exhibits to be included in the Electrical Exposition and Motor Show to be held in New York City, the second week in October.

One of these exhibits will show the use of electricity in coast defense service. It will embrace the mining of harbors, handling of big guns, signal devices and lines of communication, the use of search lights, etc., in all of which electricity plays a more or less important part. One of the navy exhibits will be the bridge of a battleship, complete in every detail, showing how electricity is used to control the great fighting ships. How electricity is employed in submarines and the new electric cooking range for warships, also to be shown in action, are other features of the navy exhibit.

A small arsenal, fully equipped and engaged in making ammunition, is to be exhibited by the ordnance department of the United States Army. The chief of this department, Brigadier General Crozier, is taking personal charge of the preparation and display of this exhibit. The electrically operated machinery and the officers and men who will use it in making ammunition at the Electrical Exposition and Motor Show, will come from the Frankfort Arsenal at Philadelphia.

However, most of the one hundred and fifty exhibits already arranged are devoted to a more peaceful use of electricity, to its constructive rather than its destructive employment. The Government also participates in this phase of the exposition, for a United States mint, actually in operation making real money, is to be shown under the supervision of the director of the Mint.

Recent Court Decisions

Digested by A. L. H. STREET

Duty to Warn Minor Employees—An employer may be found to have been negligent in permitting an inexperienced employee 18 years old to assist in tying high-voltage wires without instructing him concerning the dangers incident to such work. (United States Circuit Court of Appeals, Ninth Circuit; Betts vs. Bisher; 213 "Federal Reporter," 581.)

Discrimination by Water Companies — A water company which illegally discriminates against one consumer by allowing another a lower rate than is charged the former cannot be compelled to allow the former the lower rate. The only remedy is to compel the company to raise the rate improperly allowed the latter consumer. (South Carolina Supreme Court, Paris Mountain Water Co. vs. Camperdown Mills, 82 "Southeastern Reporter" 417.)

New York's Sunday Law—The Erie County Court in a recent opinion upholds the validity of the law enacted by the New York legislature in 1913, which requires employers in certain industries to allow their employees at least twenty-four consecutive hours rest in every seven days, except that employees may be engaged not more than three hours on Sunday in repairing boilers and machinery, and in other specified occupations which are necessary, including keeping up fires.

Idaho Public Utilities Act Valid—In a proceeding recently brought by the Idaho Power & Light Co. and the Beaver River Power Co. against the Idaho Public Utilities Commission, the Supreme Court of that state upholds the validity of the provision of the Public Utilities Act of 1913 which requires a power company to obtain a certificate of necessity and convenience from the Commission before constructing works in territory served by a competing company.

Risks Not Assumed by Stationary Engineer—In recently affirming judgment in favor of a stationary engineer, against his employer, for injury received when his overalls came in contact with a revolving setscrew on a line shaft, the Arkansas Supreme Court held that such employees do not assume the risk of being injured through the existence of defects negligently permitted by the employer to exist, unless the employee discovers the danger. In this connection, it is to be remembered that in several states there are now in force laws requiring setscrews to be safeguarded, and it is uniformly held by the courts that under such laws an employee does not assume the risk flowing from his employer's failure to comply with the law, whether the employee knows the condition of the setscrew or not.

Subordination of Water Power Rights—The rights of one who owns land along a river, and who maintains a dam therein for the development of power, are subordinate to the right of the state to control the stream for navigation purposes. And the state may so far delegate its power in this respect as to authorize a logging boom company to maintain works in a stream and its tributaries to promote floating of logs. In exercising this authority, the boom company will not become liable to one whose water power rights are thus impaired, unless the injury is unreasonable and unnecessary. This decision has just been handed down by the Minnesota Supreme Court in a case involving the liability of a boom company for interfering with a mill owner's rights.

Employer's Liability for Defective Engine—An owner of a power plant is not responsible for injury to an experienced engineer, resulting from unexpected starting of the engine, caused by a leak in a valve, if the employer was not chargeable with notice of the existence of the defect. (Alabama Supreme Court, W. R. Flowers Lumber Co. vs. Hutchins, 66 "Southern Reporter," 108.) In this case the injury occurred while the engineer was stooping over the engine, tightening brasses. The Supreme Court further holds that in such a case the burden is on the engineer to show the existence of a defect directly causing his injury and negligence on the part of the employer in permitting the defect to exist.

Storage of Gasoline as Nuisance—Although storage of gasoline on premises adjacent to or adjoining the premises of another does not constitute a nuisance in itself, so far as concerns the rights of the adjoining owner, the Michigan Supreme Court holds in the recent case of Whittemore vs. Baxter Laundry Company, 148 "Northwestern Reporter" 437, that the storage may become a private nuisance, considering the particular locality, the quantity, and the surrounding circumstances, regardless of the degree of care used in keeping the gasoline. In this case the court decided that maintenance of two steel tanks under ground for the storage of 20,000 gal. of gasoline, within a few feet of a nearby dwelling house, would constitute a nuisance, as against the owner of the house, and, therefore, an injunction was granted against such storage.

Electric Power Contract Construed—Under an agreement by an electric power company to furnish a current not exceeding 300 electric horsepower, the company cannot be required to furnish three or four times that amount to start motors, although the contract was made with reference to use of the current for that purpose; the necessity for the use of a large additional current for starting purposes not having been foreseen by either party at the time the contract was entered into. (United States Circuit Court of Appeals, Ninth Circuit; Alaska Treadwell Gold Mining Co. vs. Alaska Gastineau Mining Co, 214 "Federal Reporter," 718.) The type of motor involved in this case was the "General Electric Form K," which was found by the court to require at least three or four times the starting surge it requires to operate its load. The Court of Appeals says: "It is manifest that whether the starting surge is needed 10 sec. or 30 sec., or only one second, if the contract requires appellants to furnish it, they are obliged to have it constantly available for the appellee's use, and therefore cannot divert it to other uses without liability for damages. To read by construction into the written contract of the parties, such a requirement is therefore to read into it a most important provision not there found."

Warranty of Power of Engines Sold—When an engine is sold under a warranty by the seller that it will develop a certain horsepower, is the representation to be deemed to apply to gross power, or to net power, when geared to machinery? This interesting question was recently propounded to the Indiana Supreme Court, in the case of Winnemucca Water & Light Co. vs. Model Gas Engine Works, 101 "Northeastern Reporter," 1007. The court decided that, if the contract of sale or the surrounding circumstances do not show that it was otherwise contemplated, the warranty will be declared to apply to gross power. The contract in this case was for the sale of a gasoline, distillate, alcohol engine, "Horsepower developed at 275 r.p.m. 150 actual hp.," and contained a warranty that the engine would develop its "full rated horsepower." The court found that it was a custom in the trade to reckon the gross, and not the net, horsepower in supplying engines of a rated power, and that 40 per cent. of the rated power is the average loss from friction. The judge who announced the opinion said: "Under the tests as made, about 9 per cent. was computed for inefficiency in the generation, and in addition a 36-in. waterwheel was geared to the shaft, the percentage of reduction of power to move which is not shown, and the tests were not made by a reasonable method, so that it is impossible from the evidence to determine what power was actually developed by the engine when geared to machinery." The court concluded that, in the absence of any representation by the seller as to what net power would be developed by the engine, or notice of the net power required for the buyer's purposes, or of any representation inducing the buyer to believe that he was obtaining 150 hp. net, he had no cause of action against the seller for insufficiency of the engine in this respect.

International Association's Peoria Convention

The fourth biennial convention of the International Association of Steam and Operating Engineers was held at Peoria, Ill., during the week beginning Sept. 14. The Fey Hotel was the headquarters. There were about 200 delegates present from all parts of the United States and Canada.

The several business sessions of the delegates were held in the hall of the Knights of Columbus, conveniently situated to the headquarters. The spacious skating rink adjoining Columbus Hall was tastefully decorated and neatly arranged for the various supply houses in the display of their power-house equipment.

On Monday morning, at 11 o'clock, the opening exercises of the convention took place. Oscar Moore, chairman of the local committee, occupied the chair, and after a brief speech, he introduced Edward N. Woodruff, mayor of Peoria, who, in a kindly address, welcomed the delegates and their friends to the city. Walter S. Bush, secretary of the Trade and Labor Association, was then introduced and spoke interestingly on subjects of interest to the engineers. Matt Cummerford responded fittingly for the engineers. The meeting then went into executive session. After the appointing of the necessary committees, an adjournment was taken until 2 o'clock.

There were many features of entertainment, including shopping trips for the ladies, automobile rides through the city and visits to many of the large plants. On Monday evening, the delegates and their gentlemen friends enjoyed a smoker in the exhibition hall. Wednesday night there was a moonlight ride on the Illinois River, which was greatly enjoyed. Thursday evening, the convention journeyed to Prospect Heights and partook of a hearty supper at "Ye Olde Tavern."

Among the important business measures of the convention was the endorsement of a life insurance policy, and also the buying of property for locating permanent headquarters at Chicago.

A ladies' auxiliary was organized on Thursday, and the following international officers were elected: Mrs. George P. Amedee, Oakland, Calif., president; Mrs. Flora L. Beckwith, Spokane, Wash., vice-president; Mrs. Mary Burt, Palmer Park, Ill., secretary-treasurer; Mrs. Lilly Roberts, Oakland, Calif., general organizer; Mrs. Elizabeth Lewis, Mrs. Sarah Welton and Mrs. Daisy Kasper, trustees. This independent organization received the hearty approval of the main body.

There were upward of 30 booths on display in the exhibit hall, among them being many of the leading firms.

The present policy of the organization was indorsed by the re-election of the entire administration ticket, as follows. Matt Commerford, St. Paul, Minn., president; Milton Snellings, Washington, D. C., first vice-president; T. J. Roberts, Oakland, Calif., second vice-president; Michael Kelly, New York, third vice-president; Michael Murphy, New York, fourth vice-president; Will M. Finlay, Toronto, Can., fifth vice-president; James G. Hannahan, Chicago, secretary-treasurer; John L. McNamara, John W. Maher and P. J. Gorman, trustees.

The next biennial meeting will be held in Newark, N. J., in September, 1916.

Facts About Coke—The loss of combustible matter in converting coal into coke is from 33 to 40 per cent. The heating value of a pound of coke is approximately the same as coal. The average weight of heaped coal is 30 lb. per cubic foot. One ton of coke occupies 70 to 75 cu.ft.

NEW PUBLICATIONS

POWER AND POWER TRANSMISSION. By E. W. Kerr, Professor of Mechanical Engineering, Louisiana State University. Published by John Wiley & Sons, New York. Size 6x9 in.; 391 pages; 325 illustrations; third edition, thoroughly revised. Cloth. Price, $2.

From the pretentious table of contents, one would expect to find a store of valuable engineering information in this

book, but some of the subjects are treated in a most perfunctory manner and the entire work is surprisingly superficial, composed as it is of short extracts from works on physics, etc., and copious quotations from trade catalogs.

Several errors in makeup are noticeable even on casual reading; for example, Fig. 244 is inverted in position. Fig. 150, the text says, shows a pressure gage attached, yet none is to be seen. In the index just before "Dead Center" and "Dead Plate" is listed "Dead Boiler Feed Pump," page 146, where Fig. 153 shows a Deane pump; not Dead. The index under economizers refers us to page 591 when there are less than 400 pages in the book. And the subject of economizers is disposed of under "Feed Pipe" in a space of twelve lines and one inferior cut. The subject "Air Lift," page 282, has less than a hundred words, and the closing statement is that "The height to which the water is lifted depends upon the air pressure which is furnished by the compressor." Again, on page 157, the only reason offered for counterboring is, "The cylinder is counterbored at each end to facilitate the introduction of the piston."

The problems to be found at the close of each chapter are excellent and furnish good exercise for the student and for examinations.

New Government Publications—The Bureau of Mines, Department of the Interior, has recently issued the following new publications.

BULLETIN 38. The origin of coal, by David White and Reinhardt Thiessen, with a chapter on the formation of coal, by C. A. Davis. 1914. 390 pp. 54 pls.

TECHNICAL PAPER 34. Experiments with furnaces for a hand-fired return tubular boiler, by S. C. Flagg. 1914. 32 pp., 4 Figs.

TECHNICAL PAPER 63. Factors governing the combustion of coal in boiler furnaces, a preliminary report, by J. K. Clement, J. C. W. Frazer and C. E. Augustine. 1914. 46 pp., 26 Figs.

TECHNICAL PAPER 77. Report of the Committee on Resuscitation from Mine Gases, by W. B. Cannon, G. W. Crile, Joseph Erlanger, Yandell Henderson, and S. T. Meltzer. 1914. 36 pp., 4 Figs.

TECHNICAL PAPER 79. Electric lights for use about oil and gas wells, by H. H. Clark. 1914. 8 pp.

MINERS' CIRCULAR 17. Accidents from falls of rock and ore, by Edwin Higgins. 1914. 15 pp., 8 Figs.

Note—Only a limited supply of these publications is available for free distribution, and applicants are asked to cooperate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers cannot be granted without satisfactory reason. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

MECHANICAL LABORATORY METHODS. The Testing of Instruments and Machines in the Mechanical Engineering Laboratory and in Practice. By Julian C. Smallwood, M. E., Associate Professor of Experimental Engineering, Syracuse University. Published by D. Van Nostrand Co., New York. Limp leather binding; 332 pages; 5x7½ in.; 95 illustrations. Price, $2.50.

The subtitle is clearly descriptive of the subject matter, and while the main purpose has been to provide a handbook for the use of college students in mechanical laboratory practice, the work is one which should find a place among handbooks of engineering graduates and practical engineers who appreciate suggestions on the handling of apparatus and guidance in the essentials of engineering tests. The author gives as his reason for undertaking a subject already treated by a few admirable texts that in his own teaching there appeared need of a brief work on the broad principles of experimental apparatus and methods. The book does not contain lengthy or detailed descriptions of instruments of any class, but it is assumed that the reader is familiar with the general principles and purposes beforehand. In dealing with any class of instruments, the text explains only the broad principles of that class or a subdivision, so that only a brief explanation covers any specific instrument.

With the purpose of making more direct and simpler presentations, the illustrations are diagrammatic without detailed drawings or pictorial effect. While this method is undoubtedly sufficient, and for some reasons may be better for the explanation of abstract principles, the work could have been made no less valuable to students, and certainly would have been more acceptable to practical engineers, if the plan of illustrating had been carried out less rigorously, as by the addition of good pictorial illustrations of typical instruments and appliances.

Two main divisions of the work deal respectively with testing of instruments and machines. The first is subdivided, so as to deal separately with a group of instruments of a single type for a given purpose as instruments, and under each subdivision the principles of the instruments considered are first related and then are given the methods of testing them. Part 1 relates to the principles and calibration of instruments for determining weights and forces, pressure, angular velocity, brakes and dynamometers for measurement of power, steam engine indicators, planimeters, temperature and heat, oil and belt testers.

Part 2, on the analysis of combustion, is subdivided under heads of determination of constituents of fuels, and heat values of fuels and products of combustion.

Part 3, "The Testing of Power Plant Units," is subdivided under principles and methods of testing steam engines, steam turbines, conducting economy tests and testing steam pumps, air machinery and water motors.

The work being exclusively on the subject of testing, the principles of all except a few types of engines and topics such as thermodynamics have not been included. Only simple algebraical formulas are employed. The author's style is generally terse and clear, and the text is additionally clarified by being well paragraphed. The work is printed on good paper, in large, readable type. The subheads of the text are in bold-faced type, and for readier reference there is given a convenient alphabetical index in addition to a complete tables of contents, showing the divisions and subdivisions of subjects.

Government Aid in Selection of Coal—Requests for data relative to coal analyses are frequently received. For the information of engineers who desire the latest published material we advise writing the United States Geological Survey, which each summer issues a small pamphlet giving analyses made by the Bureau of Mines of the coal samples that the Survey has collected during the year. The heating value is given with almost all the analyses, so that it is easy to determine which of two coals is the better. The bulletin also gives a brief description of the samples, including a section of the coal at the point sampled, and an outline of the different classes of coals recognized by the Geological Survey. A copy of Bulletin 541-K may be obtained free of charge on application to the Director of the United States Geological Survey, Washington, D. C.

OBITUARY

John S. Smith, 83, who was an engineer officer in the navy during the Civil War, died on Sunday, Sept. 20, at his home, 161 Madison St., Brooklyn. He was engineer of the "Stonington," of the Fall River Line, at the time it came into collision with the "Narragansett." He leaves three sons and two daughters.

PERSONALS

Edward J. Kunze, who for the past four years has been assistant professor of mechanical engineering at the Michigan Agricultural College, has been appointed professor of mechanical engineering of the Oklahoma Agricultural and Mechanical College, in charge of the department.

NEW EQUIPMENT

ATLANTIC COAST STATES

Lightning recently damaged the Bangs power station of the Central Maine Power Co., Waterville, Maine, to the extent of $30,000.

Bids will be received by Walter B. Forbush, Comr. of Pub. Bldgs., Newton, Mass., until Sept. 30, for installing heating and ventilating apparatus in the Claflin School buildings on Walnut St., Newton. Alfred S. Kellogg, 53 State St., Boston, is Engr.

The Board of Selectmen, Reading, Mass., contemplates making improvements and extensions to the municipal electric-light plant at an estimated cost of $8000. Arthur G. Sias is Mgr. and Supt. of the plant.

Bids are being received by Greenwood & Noer, Consult. Engrs., Hartford, Conn., for the construction of a power house at Georgetown, Conn., for the Gilbert & Bennett Mfg. Co.

SOUTHERN STATES

The construction of an electric-light plant to cost $100,000 is contemplated by the Beckley Utilities Co., Beckley, W. Va. James Imboden, Charleston, is Consult. Engr.

Bonds for $40,000 have been voted by the citizens of Quitman, Ga., the proceeds of which will be used for the enlargement of the electric-light plant. New equipment will be purchased. J. M. Curtright is Supt.

THE POWER STUDY COURSE

The Engineers' Study Course from the weekly issues of *Power* is now favorably known, wherever that paper is read, because it gets down to the rock bottom of things, as no other series of articles ever did.

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The appointment of Charles H. Bromley, Associate Editor of *Power*, to the office of Chairman of the Educational Board of the New Jersey N.A.S.E., is ascribable to his plain and forceful teachings and writings which have always been in language that the engineer understands.

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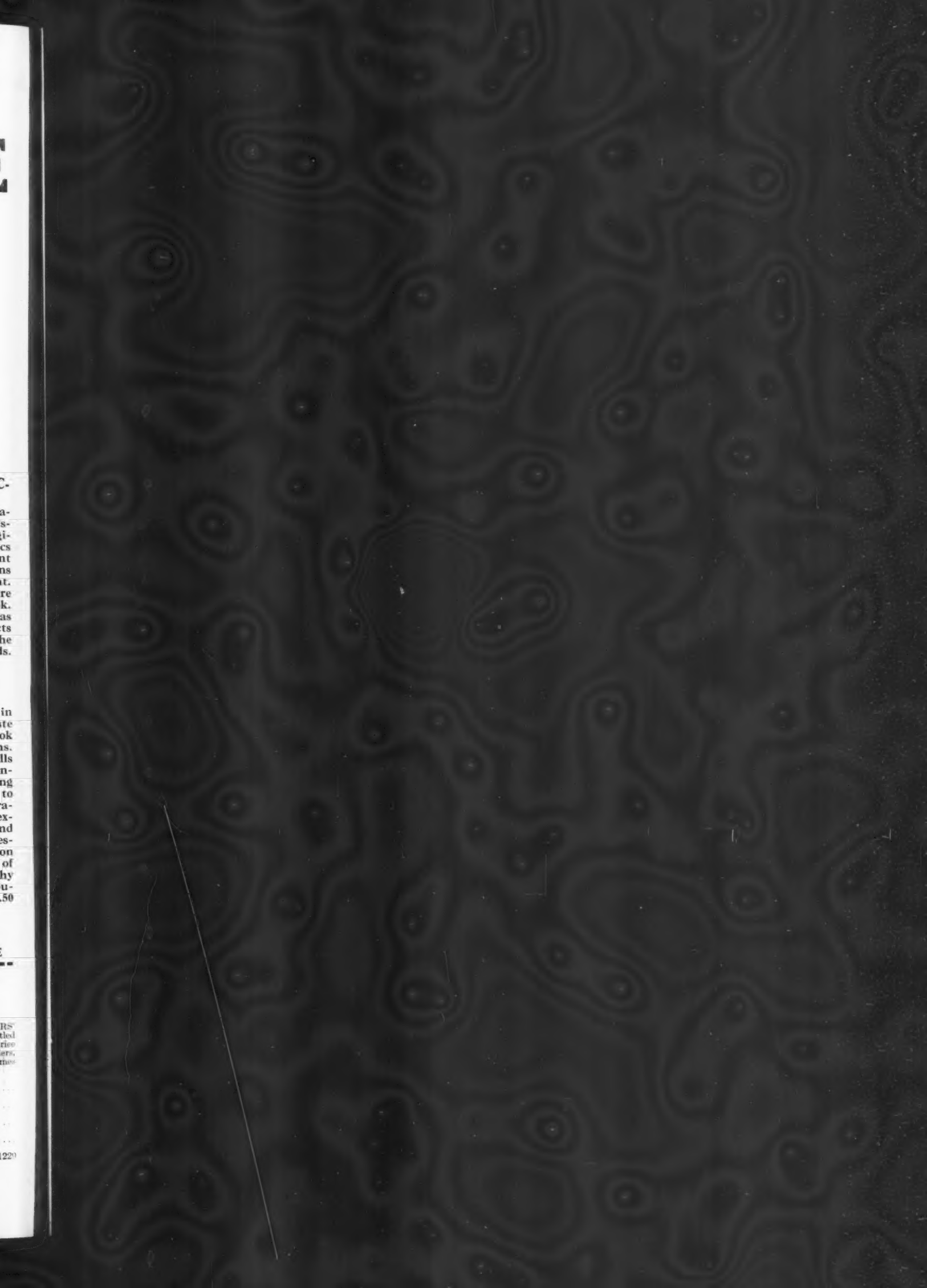


The Type "E" Stoker
Is Used the World Over

Because it burns economically all kinds of bituminous coals WITHOUT SMOKE.

It automatically meets any load from 75% of rating to 300% rating.

It is adapted to your present boiler settings with but slight changes.

Combustion Engineering Corporation

Covering the entire field of combustion—hard or soft coal—hand-firing or stoking.

If your problem is one of combustion, let us show you how our stokers and grates can solve it to your advantage.

Combustion Engineering Corporation

Owners and Manufacturers of

Type "E" Stoker—For Bituminous Coal. The Grieve Grate—For All Hand-Fired Fuels.

Sole Representatives

Coxe Traveling Grate Co.—The Automatic Anthracite Stoker.

NEW YORK CITY
11 Broadway

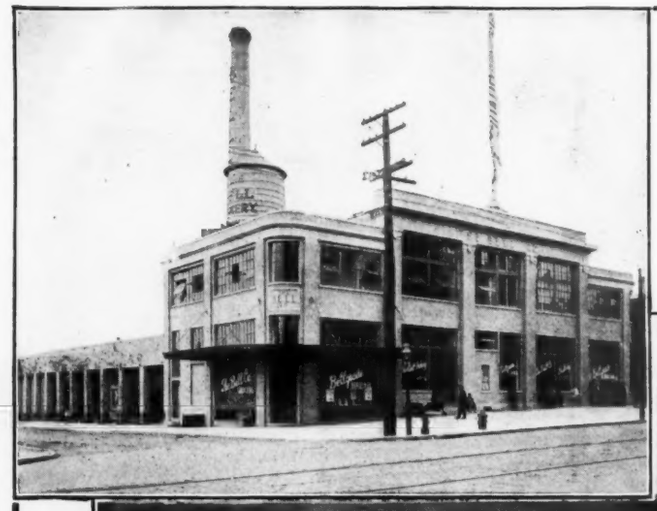
PHILADELPHIA, PA.
The Bourse

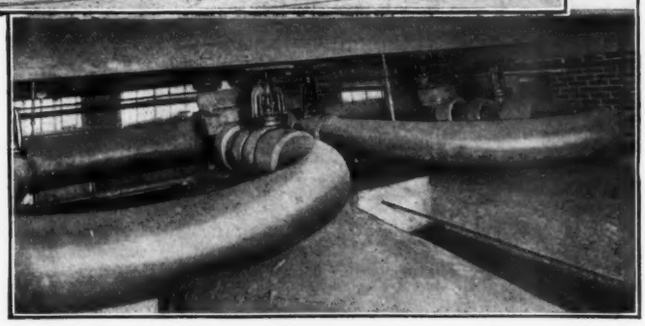
PITTSBURGH, PA.
Geo. J. Hagan Co.

CHICAGO
Fisher Bldg.

SALT LAKE CITY
American Stoker Co.

HAZLETON, PA.
Markle Bank Bldg.





A Modern Baking Co.'s Selection

The Bell Bakery, Philadelphia, Pa., is provided throughout with modern machinery and ovens of the latest and most economical types. Every precaution was taken in the design and selection of the equipment to secure continuous operation over long periods of service.

Two 5″ Jenkins Bros. Globe Automatic Equalizing Stop and Check Valves were installed in the boiler connections and about 200 Jenkins Bros. Globe and Angle Valves were used throughout the plant.

Jenkins Bros.

Automatic Equalizing Stop and Check Valves

prevent a complete shutdown of the plant when any single boiler is disabled by a burst tube or other internal rupture which causes the sudden release of high pressure steam, by closing automatically and instantly shutting off the steam flow from the header to the damaged boiler. The valves cannot open until the pressure inside of the boilers to which they are attached is slightly in excess of that in the header. The pressure between all boilers in operation is therefore automatically equalized.

This feature also renders it impossible for any one to turn steam into a cold boiler.

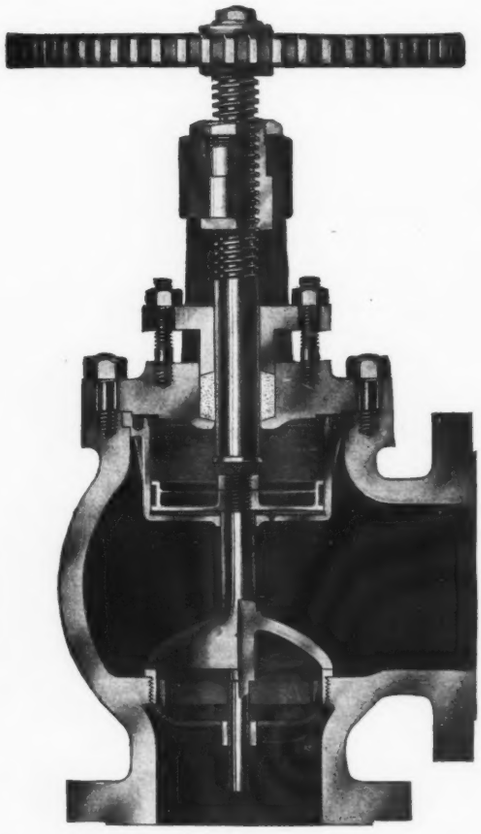
When desired the valves can be tightly closed by means of the hand wheel like an ordinary globe valve.

Note that the internal dash pot is constructed of bronze and cannot corrode or stick. The valves seat quietly without shock, hammer or chatter.

Made in sizes 4″ to 10″ inclusive from our extra heavy globe and angle patterns. Iron body valves guaranteed for 250 lbs. working steam pressure.

Also furnished with cast steel bodies, and monel metal mountings for superheated steam at 350 lbs. working pressure and 800 deg. F. total temperature.

Look for the Diamond Trade Mark and Signature cast in the body. No valve is a genuine Jenkins Bros. without it. Write us for catalog.



REG. U.S. PAT. OFF. TRADE JENKINS MARK Jenkins Bros.

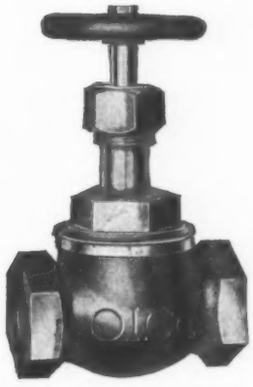
Jenkins Bros.

80 White Street, New York — **524 Atlantic Avenue, Boston**
133 N. 7th Street, Philadelphia — **300 West Lake Street, Chicago**
Jenkins Bros., Limited, Montreal, Canada, and London, E. C., England

O.I.CO. VALVE

O. I. Co. Angle Valve

O. I. Co. Y Blow-Off or Straightway Valve



O. I. Co. Composition Disc Globe Valve

Sets a New Standard

By standing up under a pressure up to 225 lbs. the O. I. Co. Valve establishes a new standard for composition disc valves, puts the seal of truth on our claim that it's a better valve and proves the confidence of your brother engineers is not misplaced. Here's what the Delphi Engineering Company of Delphi, Indiana, writes:

"In reply to yours of the 6th relative to efficiency of your **1" O. I. Co. Composition type Globe Valves** used by us the past 3 years we are glad to inform you that this valve is the best we have ever used and we have tried all types of disc valves.

"The one thing which especially commends your valve to us is the **efficiency of the disc,** it being the best we know of.

"**Your valve is subjected to very hard usage,** the valve being opened and closed on the average of once every 30 seconds throughout the day of 10 and 12 hours.

"We expect to use several hundred of your valves again next year."

A Free Disc—A Free Valve

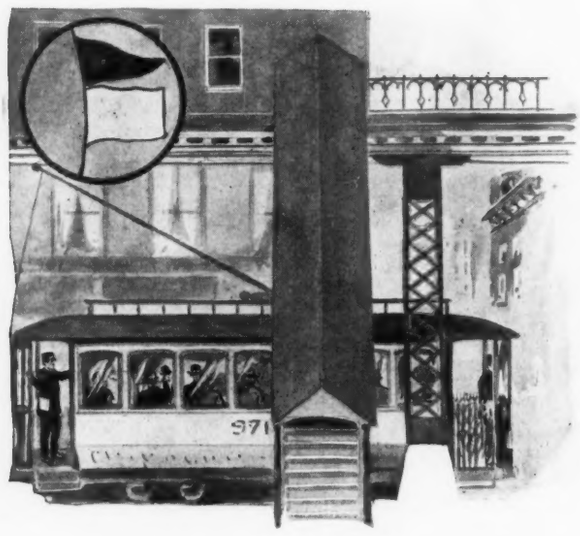
As an engineer you owe it to yourself to know the valve of the new standard. You can get acquainted without cost if you write now for our **free valve trial offer.** When writing just state size of **O. I. Co. Composition Disc** you want and we will send it **absolutely free.**

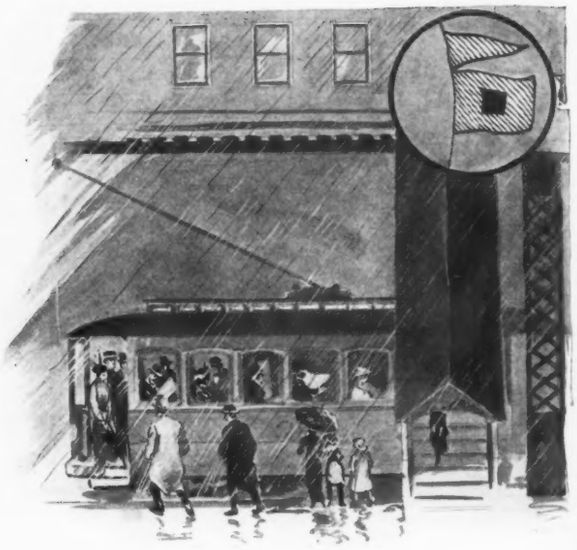
Place it in a valve and watch it hold up without a pit, crack or break on any pressure up to 225 pounds—watch it wear to the thinness of the paper this advertisement is printed upon—watch it give you 300 per cent. longer service than any other disc. Write for the free valve offer and disc now.

The Ohio Injector Co.

110 South Main Street **Wadsworth, Ohio**

Also Manufacturers of Improved Injectors, Lubricators and Other Steam Specialties





When This Changes to This

When fair weather flags suddenly change to ominous storm signals, when sunshine changes to darkness, when footgoers suddenly change to elevated and subway and surface car passengers, has your station a combustion system that can handle that situation and not go down and take the count? You are fixed right if it is

The Taylor Stoker

With the TAYLOR STOKER behind you, you need never tremble lest you be caught in a corner with a quick call for steam that you can't meet.

The unexpected peak has no terrors for the TAYLOR STOKER because this system incorporates the three principles necessary for complete flexibility of operation: (**1**) Underfeeding by mechanical means. (**2**) Mechanical control of air and coal. (**3**) Automatic cleaning.

The first (1) and second (2) permit any desired quantity of coal to be burned as rapidly as demanded, and the third (3) insures a clean and therefore fully effective fire.

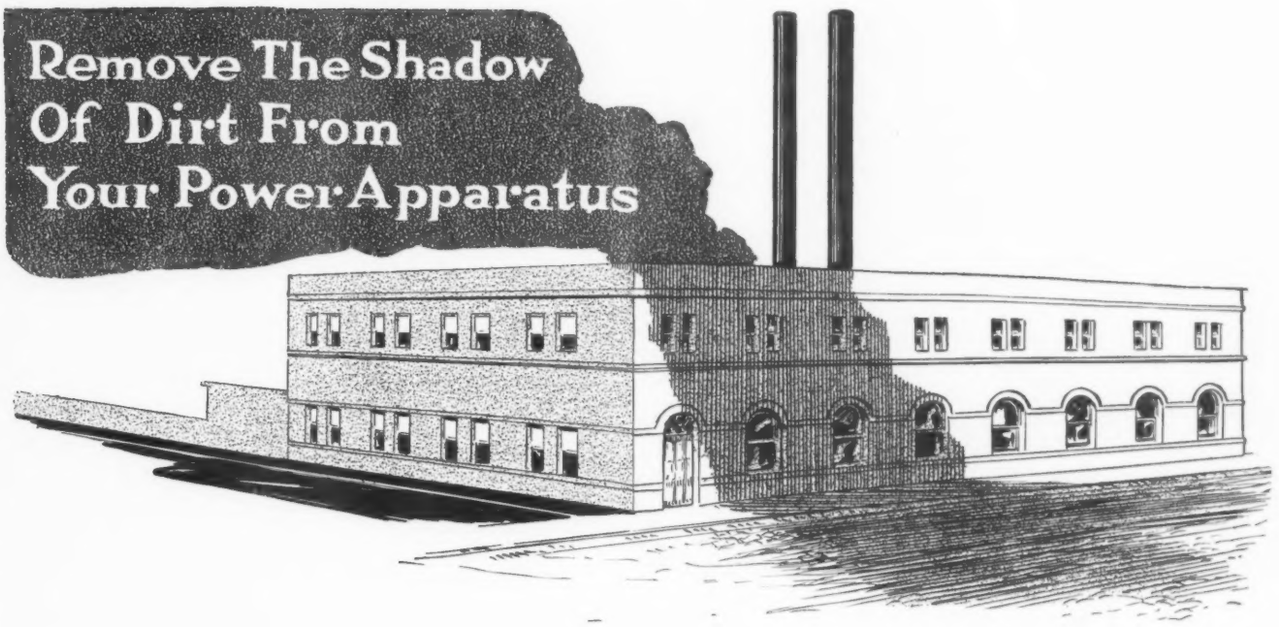
Don't go blundering along with an antiquated combustion system any longer—a combustion system that BARELY SQUEEZES YOU OVER your peaks—with a frightful loss of efficiency and a smudge of smoke. Get the modern system — flexible — automatic — smokeless — labor saving — The TAYLOR.

A Few of the Many Electric Systems Equipped with TAYLOR STOKERS:

Boston Elevated	45,000 Kw.
Consolidated G., E. L., & P. Co., Baltimore	35,000 Kw.
Elmira Water, Elec. L. & R.R. Co.	10,000 Kw.
Interboro R. T. Co., New York	130,000 Kw.
Iowa Railway & Light Co., Cedar Rapids,	1,200 H.P.
Potomac Electric Co., Washington	2,400 H.P.
Rhode Island Co., Providence	15,000 Kw.

American Engineering Co.,
Philadelphia

Remove The Shadow Of Dirt From Your Power Apparatus



This dirt is not on the outside where the first good rainstorm would wash it away. It's inside. It's creeping along the pipe lines and heading straight for the vital parts of your power apparatus where it can do the most damage. The best way to keep it out is by installing the

C. C. Self-Cleaning Strainers

Put one in each pipe line before each unit of power apparatus. Put one especially before each turbine, engine, pump, steam trap or any important valve.

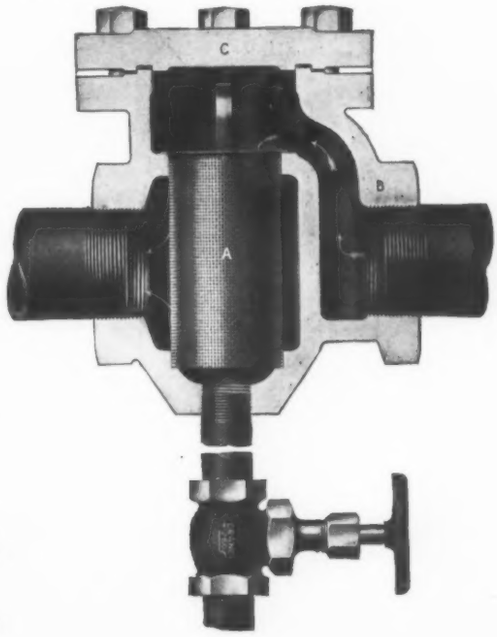
It will cost you but little to get this absolute protection from dirt in pipe lines. It will cause you but little trouble.

"When an engineer's foresight is as good's his hindsight."—says the Crane Man, "there's less shadows on his reputation and more sunshine in his pay envelope."

Only 3 Parts

The C.C. Self - Cleaning Strainer consists of but three parts and it's as easily installed as a pipe fitting. It has large strainer area and the screen is swept clean when you open the Blow-Off Valve by the scouring action of the element passing through at high velocity.

For full particulars there's our Bulletin B-6. Send for a copy.

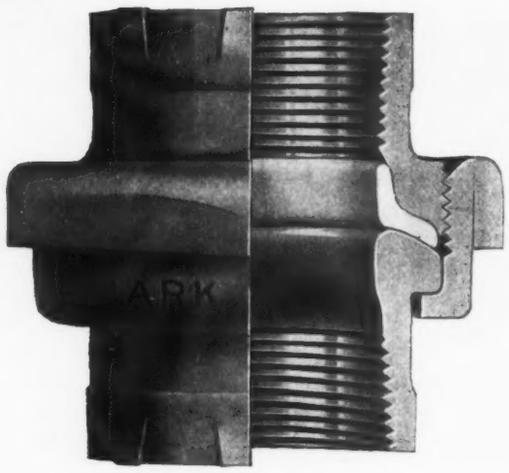


CRANE CO.

Bridgeport Division

Bridgeport, Connecticut

Make 1915 a Year of Emancipation *from* Pipe Union leaks and losses



The Remedy is at hand; it's use means Economy

If you are tired of paying bills for replacement of malleable or cast unions that are new or almost new—

If you are disgusted with the vast waste of time and labor necessary to continual tightening of leaky malleable unions—

If you dread that task of dislodging and replacing rusted unions that are "frozen" fast to the pipe—

THE MARK Cold Drawn Steel Union

puts an end to all these troubles, because it is *made right*, from the *right* materials—

Cold Drawn Steel with Soft Brass Seat

Wrought Steel is the right material for a pipe union because it is tough, resists sudden shocks, and especially because it expands and contracts under changes of temperature in the same ratio as the wrought pipe on which it is used.

It is also the right material because it can have none of those sand-holes or similar structural defects which are unavoidable in malleable iron or any other cast product.

Our booklet describes our interesting process of cold-drawing the steel parts of the Mark Union from open Hearth Strip Steel, and explains how we protect both body and threads from rust and corrosion.

Send for it, and ask for a sample union.

MARK MFG. CO.

MAKERS of Standard Full Weight Steam, Water, Gas and Line Pipe, Black and Galvanized

1105 Dodge Avenue Evanston, Illinois

Peerless Piston and Valve Rod Packing

If we could shout on paper we would yell

Peerless!!!

Then quietly settle down to tell you that Peerless Piston and Valve Rod Packing saves time and money.

We stop right there long enough to sell you enough to try it out and await your verdict.

That "trying it out" is the main thing. If we can get you to do this, we can convince you that Peerless has no superior, and we think, no equal.

We would like to leave that to your judgment.

Order a box today and try it yourself.

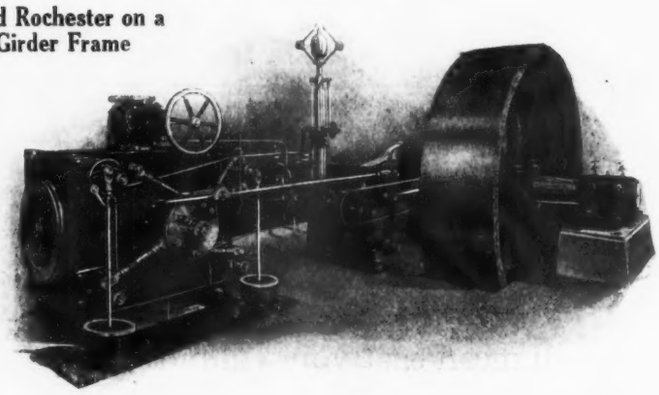
Manufacturers of the celebrated Rainbow Sheet Packing.

PEERLESS RUBBER MFG. CO.

16 Warren Street New York

FOR SALE EVERYWHERE.

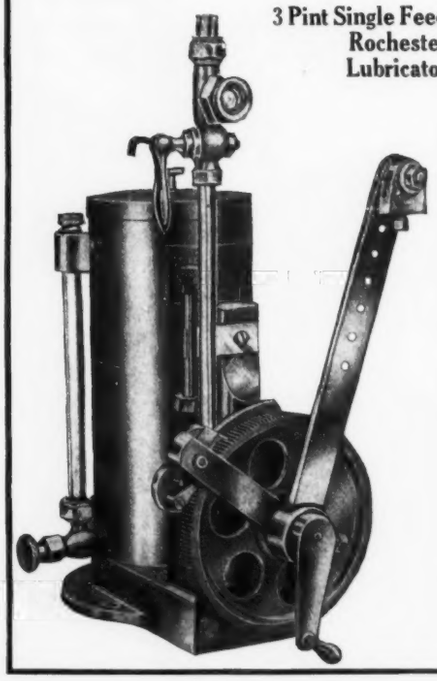
3 Pint Single Feed Rochester on a Standard Heavy Girder Frame Harris-Corliss Engine



Rochester Automatic Lubricator Makes Oil Earn Its Cost

A lubricator that does not feed enough oil is as *wasteful* as one that feeds too much. The oil fed does not serve the purpose of lubrication therefore it is oil lost. By never feeding too little nor too much but **always the right amount** the Rochester Automatic Lubricator makes oil earn its cost. Whether the amount desired is a tiny drop or an almost constant stream once set the Rochester feed will never vary. That is efficiency. It will save from 25 to 60 per cent. over the lubricator you are now using. That is economy. Put this efficient, economical lubricator to work in your plant without cost. Read the offer below.

3 Pint Single Feed Rochester Lubricator



Take the Word of Your Brother Engineers

Great Saver of Oil

"The Rochester is a great saver of oil and requires little attention,"—**Henry Keam, Engineer, Delaware and Hudson Coal Co., Plymouth, Pa.**

Feeds Under all Conditions

"It obtains for you a positive feed under all conditions, thereby doing away with the danger of cylinder running dry, oiler not feeding properly or perhaps not at all,"—**Engineer Alvin C. Luft, Slater & Co., Inc., Webster, Mass.**

Saves Trouble—Saves Money

"It saves trouble for the engineer and money for the employer"—**Daniel Steinheller, Benedict Bissel & Co., Tuckahoe, N. Y.**

Try a Rochester Free Write now for Catalog P. Select size and type Rochester wanted and we will send it to you, shipping charges prepaid. TRY IT 30 DAYS FREE. If it doesn't live up to our guarantee—to save 25 to 60% oil—send it back. We will take your old lubricator, regardless of make, age or condition as part payment.

GREENE, TWEED & CO., 109 Duane Street, New York

ENGLISH AGENTS—Jenkins Bros., Ltd., 95 Queen Victoria Street, London, E. C., England.

A McClave Grate in Your Plant Will Mean Money in Your Pocket

It will mean that you will burn a cheaper grade of fuel without any loss of power.

The design of the McCLAVE GRATE is such that the above result may be accomplished *economically*. It does not waste the fuel, it *burns* it and produces a maximum number of b.t.u. per ton.

No sifting of coal through the grate bars—no "cut-up" fires. Now is the time to investigate.

Let us send you our Catalog "G" giving complete details.

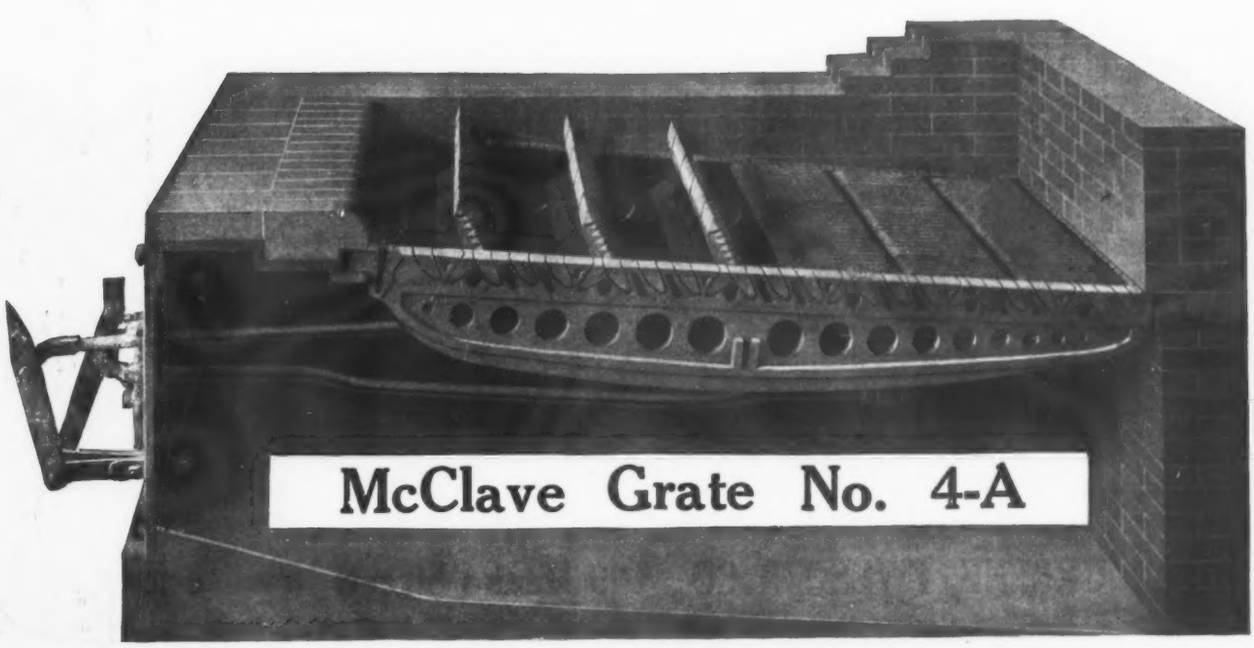
McClave-Brooks Co.

Scranton, Pa.

Branch Offices:

New York, 50 Church St.
S. C. Smith, N. Y. Manager

Chicago, 706 Fisher Bldg.
F. G. Smith, Manager



TRADE

PENBERTHY

MARK

AUTOMATIC INJECTOR

"XL-96"

EJECTOR

"A LIQUID LIFTER"

For the transferring of water from one receptacle or level to another; such as from flooded cellars, fly-wheel pits, etc.

Catalog on request.

SAFEGUARD

AUTOMATIC WATER GAGE

A thoroughly reliable automatic gage—constructed to sell at the same price as the less [illegible] reflex-body gage.

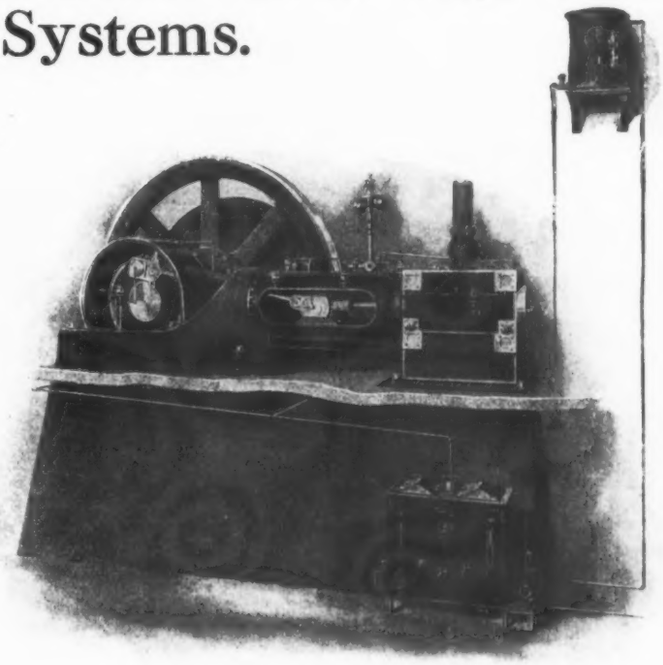
Write for interesting descriptive matter.

THE PENBERTHY INJECTOR Co. Detroit, Mich. U.S.A.

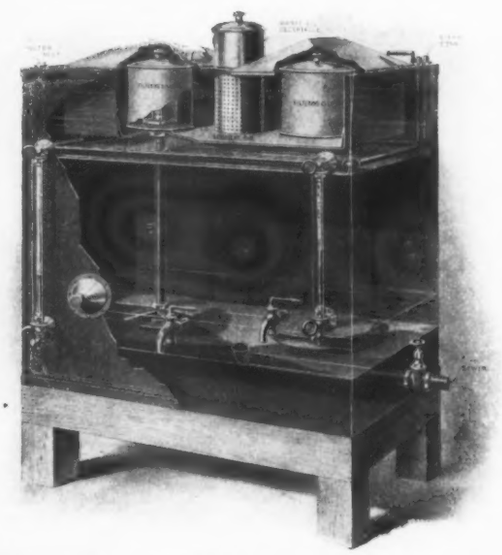
A Simple "Burt" Installation Which Saves from 70 to 90% Over Hand Oiling Systems.

This Burt Oil Filtering System feeds oil to the different bearings by gravity from the overhead oil reservoir. After passing through the bearings, the oil is piped to the oil filter in the basement where it is purified and again pumped to the reservoir. The whole system operates automatically and requires very slight attention.

An equipment as illustrated will save from 70 to 90 per cent. over hand oiling, and the result derived will be better, thus reducing friction and expense for repairs.



The "Burt" Oiling System



Engineers can install Burt Oil Filtering Systems in their spare time and thus save the expense of having experienced workmen sent to the plant.

In most plants, the oiling devices previously used on the engine can be used with the "Burt."

We furnish the Oil Filters, Oil Reservoirs, and the Oil Pump. Any engineer can install the piping.

As the power plant increases in size, additional "Units" can be installed and connected with those in operation allowing any number of filters to operate separately or together as desired.

Our 128-page catalog fully illustrates and describes our Burt Oiling System, also the Cross and Warden Oil Filters, and the Burt and Standard Exhaust Heads. Copy will be cheerfully sent upon request.

The Burt Mfg. Co., 232 Main St., Akron, O., U. S. A.

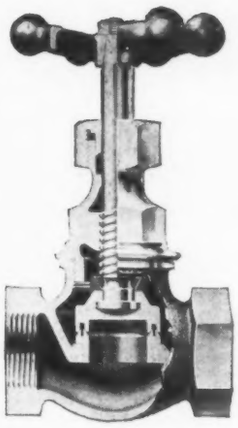
Largest Manufacturers of Oil Filters in the World.

We also manufacture a complete line of Exhaust Heads and Ventilators.

TRADE-MARK CROSBY

TRADE-MARK CROSBY

The Valve with Double Seating Capacity—Crosby Spring-Seat Valve



One trouble about discrimination in valve buying is that they all look alike.

And yet *inside* there may be differences that make the gap between efficiency and failure.

Now, with this in mind, please look at the sectional cut of the Crosby Spring Seat Valve.

Note the conical seats, the characteristic "difference" of this valve; they present a double seating capacity, removing the liability of leaking or wearing in use.

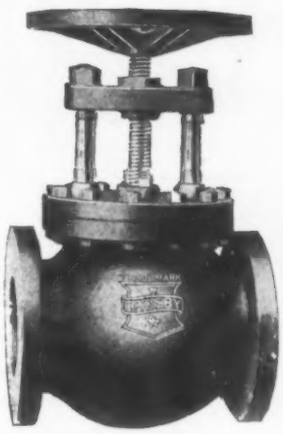
The groove, which is central in the two seats, permits of a springing action when they are together, preventing them from jamming when the valve is closed, allowing a freedom of accommodation when subjected to any variation of temperature.

Add to this big advantage, all the other advantages, such as all parts interchangeable, full opening, thoroughly tested, guaranteed, etc.

That is why you should be using the Crosby.

Write for prices and particulars.

Our large book of Steam Specialties sent on request.



Crosby Steam Gage & Valve Company

BOSTON NEW YORK CHICAGO LONDON

STEAM · CROSBY · SPECIALTIES

STEAM · CROSBY · SPECIALTIES

Valves—Fittings—Flanges

Pipe Bends—Welded Headers

Complete Power Piping Systems

Best Manufacturing Co.
Pittsburgh, Pa.

Specialists in Power Piping for more than 30 years.

Let Us Solve Your Meter Problems

We can supply you with Venturi Tube Meters or V Notch Weirs for metering water in your Power Plant.

SIMPLEX METERS

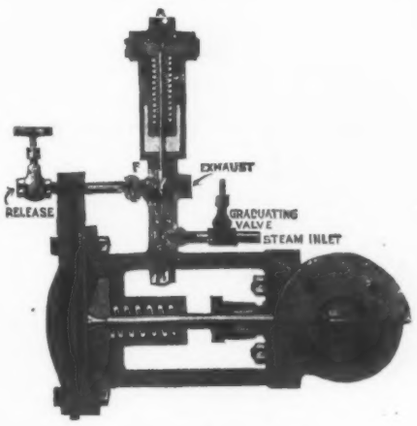
Let us figure with you. Prices, tests and other data upon request.
See half page advertisement issue first of each month.

SIMPLEX VALVE & METER CO., 112 No. Broad St., Philadelphia, Pa.

Representatives: New England—Mr. Geo. W. Stetson, 141 Milk St., Boston, Mass. Canada—Francis Hankin & Co., Montreal, Toronto, Vancouver.

Use
Davis Valve Specialties
For The Automatic Regulation Of Pressure

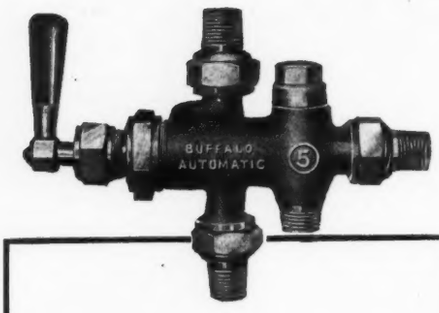
The *Squires* Reducing Valve



Write for Catalog A-10

The C. E. Squires Co.

East 40th Street and Kelley Avenue
Cleveland, Ohio



At Your Dealer's

"Buffalo"

Automatic Injector

An injector to be used under any conditions not demanding the double tube. It's a single tube, "restarting" injector. Its wide range—its simplicity and ease of adjustment are features. It's always ready to start under all conditions.

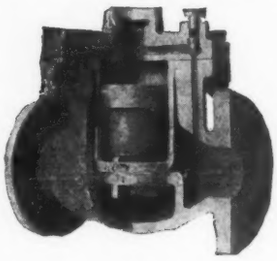
Our catalog is a good booklet for your files. Copy on request.

Sherwood Mfg. Co.

1704 Elmwood Ave., Buffalo, N. Y.

220 Broadway, New York City.
A. W. Barnes, 49 Federal St., Boston
Advance Packing & Supply Co., 11 N. Franklin St., Chicago.
Philadelphia—27 S. Eighteenth St.
Green & Boulding, Ltd., 28 New Bridge St., E. C., London.

"Perfect Control"



Our Hydromatic Water Control Valve is considered the "Best."

Our Improved Hydromatic is "Better than that."

Maintains Automatically an absolute, constant Water Level.

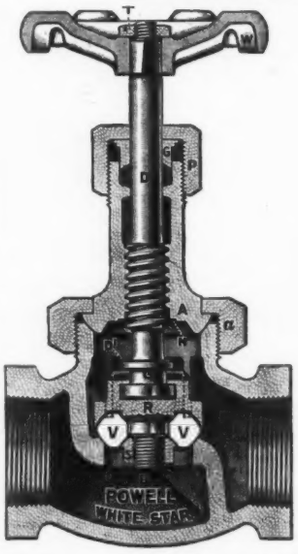
If you are not a user you should be. Our catalog tells you all about it. Write today.

The Engineers Appliance Company

884 Wheelock Road, N. E. **Cleveland, Ohio**

POWELL VALVES

(Especially The "White Star" Valve)



Five Points of Efficiency Combined in the Powell "White Star" Globe Valves

1. Body symmetrically designed and well proportioned.
2. Union bevel ground joint connection between body and bonnet.
3. They have Regrindable, Reversible and Renewable non-corrosive "Powellium" discs.
4. Observe illustration of disc holder "R" easily removed from stem "D" when necessary for repairs.
5. All working parts are interchangeable. Stem can be repacked under pressure.

Ask your dealer for *"Powell Valves"* or write us.

THE WM. POWELL CO.

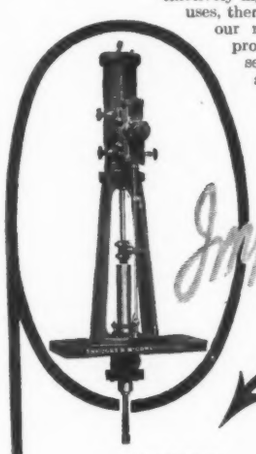
DEPENDABLE ENGINEERING SPECIALTIES.

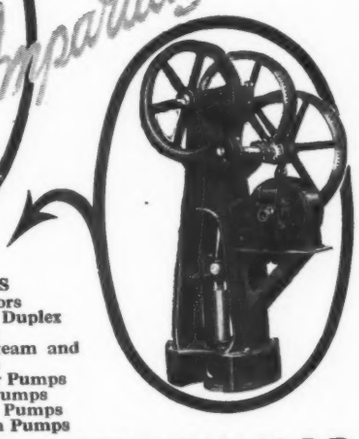
CINCINNATI, O. 3-6

DEPENDABLE PUMPS
In All Types For All Uses
STEAM DRIVEN——POWER DRIVEN

Being able to furnish from our own Factories distinctively high class Machinery in all Types for all uses, there is no tendency or occasion to restrict our recommendations to any given line of production. Name your conditions of service and we will give advice as to type best suited.

Impartial Advice





CATALOGS
391—Air Compressors
401—Single and Duplex Power Pumps
451—Deep Well Steam and Power Pumps
411—Triplex Power Pumps
421—Centrifugal Pumps
301—Single Steam Pumps
311—Duplex Steam Pumps

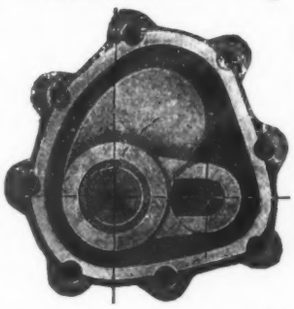
THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO.

Blow-off Valves That Stand Up

Equip your boilers with Scully "Everlasting Blow-Off Valves" and your troubles end. They are built **without** packing—have a self-cleaning and self-grinding seat, straight through blow and naval bronze working parts.

Over 200,000 Everlasting Blow-off Valves Sold to Date.

Try one for 30 days at our risk. Remember it's guaranteed drop-tight for two years with a Scully guarantee.



Scully Steel & Iron Company, Chicago, Ill.
Down Town Office: 1127-208 So. La Salle Street

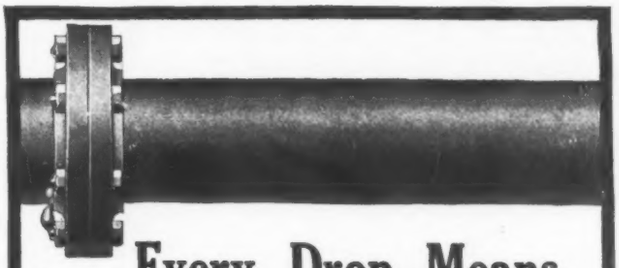
Perfect Insulation for Steam Lines

MICHIGAN PIPE CASINGS
Their use on your steam and hot water lines will result in a very material saving to you.
Proofs. Write for Booklet today.

THE MICHIGAN PIPE CO., 1-3 BAY CITY, MICH.

RILEY Self-Dumping
Underfeed **STOKER**

SANFORD RILEY STOKER CO., Ltd.
Worcester, Mass.



Every Drop Means Your Money Wasted

$33.80 per year is what a tiny 1-16" leak in one of your steam lines will cost you, if your boiler operates at 150 pounds pressure. (This figure is arrived at by a very careful engineering analysis). Just one single leak, mind you. And you know only too well that a leak will not stay small. It is bound to grow; and the faster it grows the more it costs you. Usually you must stop your whole plant to fix it. Over 8000

SIMPLEX Pipe-Joint Clamps

are stopping leaks and saving money for plant owners everywhere. They can be applied in five minutes and save not only the waste from the leak, but also the shut-down. A typical letter showing how they act is this one from Louisiana.

Gentlemen:—

I would estimate the saving to us on these two clamps as over $100.00. I want one more at this writing; will you please send it via Parcel Post, if possible—it measures 7¼" for a seven inch pipe.

Thanking you for your prompt attention I beg to remain,
Yours very truly,
Lawrence F. Villermin,
Trustee of Public Property,
New Siberia, La.

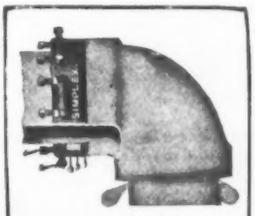
You can leave a Simplex on a joint as a permanent repair or apply it to and remove it from as many different leaks as you wish.

It is for this emergency use that at least one should be a necessary part of every plant equipment.

By simply telling us the size pipe you would like to test it on, you can get a Simplex for 30 days' free trial right where you can watch it work.

Give **complete** address in writing.

Yarnall-Waring Co.
Mermaid Ave., Chestnut Hill
Philadelphia



Description

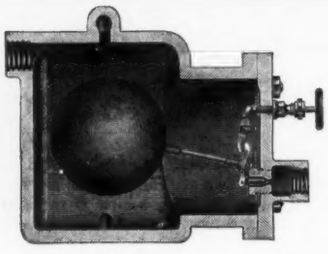
1. Square packing ring, forced against leaky joint. 2. Inside ring, forced against packing 1 by screws 4. 3. Outside ring, bolted around pipe by bolts 6, secured by set screws 5, prevents slipping when adjusting screws 4.

"Laclede-Christy" Chain Grate Stokers

Laclede-Christy Clay Products Co.
St. Louis, Mo.

Write for Catalogue

RELIANCE STEAM TRAPS



Perfect in Operation— Thoroughly Reliable

Put an end to the enormous loss and danger due to the presence of condensation in your pipe lines. ¶They are exceptionally simple and reliable. Absolutely steam tight. ¶Note the perfect accessibility. A turn of outside hand wheel raises valve off its seat, permitting trap to be drained and freed from sediment or obstruction. ¶Seamless copper float, tested to 200 lb. pressure. ¶Moderate in price. Fully guaranteed.

Write for interesting bulletins.

The Reliance Gauge Column Company
75 E. Prospect Street, Cleveland, Sixth City
Eastern Office, Cor. 18th and Market Sts., Philadelphia, Pa.

FOSTER SUPERHEATERS

Installed in any type of boiler without change in setting. Uniform superheat guaranteed.

Power Specialty Company, 111 Broadway, New York
Chicago Boston Philadelphia San Francisco Pittsburgh Birmingham, Ala.

The Genuine has this Name on each cleaner.

Is not on imitations.

"Combination" Scraper and Brush

Cleans "coming" and "going." Leaves the boiler tubes clean and free from soot. The chilled scraping edges prevent wear. Spring is adjustable and protected from heat and soot.

Isn't this just what you want?

A. W. Chesterton Co., 64 India Street, Boston, Mass.

The Lehigh Mechanical Stoker
Fullerton, Pa.

A REAL STOKER

NO POKING — NO SLICING
SMOKELESS—HIGH EFFICIENCY—AUTOMATIC

Rapid and Safe

Strong and Simple

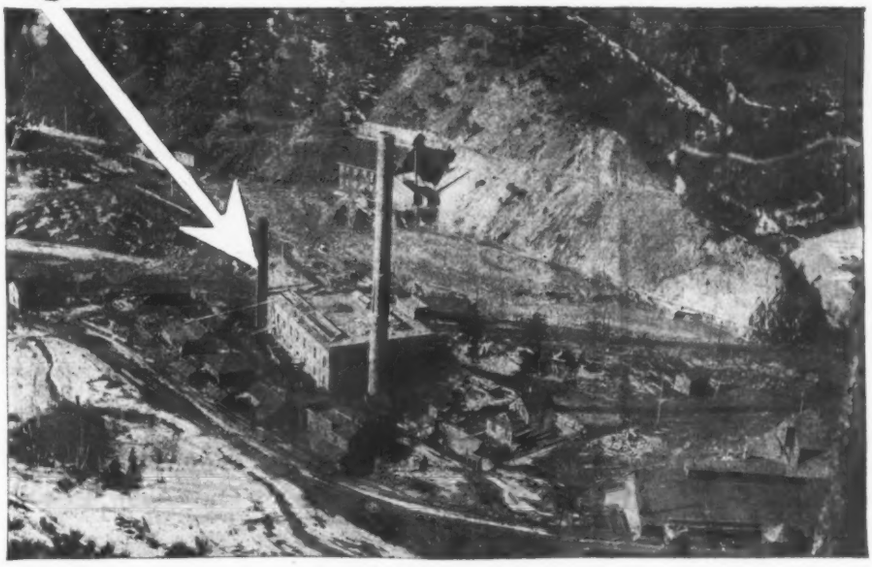
Write for Catalog Today

ROTO TUBE CLEANERS
THE ROTO CO., Hartford, Conn.

Get results with Roto

At, and Above Rating, with Low Grade Lignite

That is the way they run their boilers at the plant of the Consolidated Power & Light Co., at Pluma, South Dakota. The low grade lignite containing a high percentage of moisture is burned efficiently—the flexibility and responsiveness of the Jones Stokers making it possible to automatically maintain an even steam pressure under most variable loads even with this low cost fuel.



JONES

Under-Feed Stokers

are producing results like these in hundreds of power plants. They are easily meeting the peak loads—developing more horsepower per boiler and giving smokeless combustion—always with a fuel saving and far less labor in firing.
Our monthly Publicity Bulletin gives exact data on the newest installations.

Get your name on our mailing list and find out what the right stoker can do.

The Under-Feed Stoker Company of America

General Offices
Harris Trust Building, Chicago

New York, Detroit, Buffalo, Boston, Kansas City, Toledo, Atlanta, Philadelphia, Minneapolis, Cincinnati, Pittsburgh, Denver

The Babcock & Wilcox Company
85 Liberty Street, New York

WATER TUBE STEAM BOILERS

Steam Superheaters—Mechanical Stokers

Barberton, Ohio—WORKS—Bayonne, N. J.

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SPRINGFIELD BOILERS

WATER TUBE BOILERS
INTERNAL FURNACE BOILERS

Catalog on Request.

SPRINGFIELD BOILER & MFG. CO.
SPRINGFIELD, ILL. 2-2

EDGE MOOR IRON CO., EDGE MOOR, DEL.

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EDGE MOOR
WATER TUBE BOILER

THE BOILER FOR CLASS A SERVICE.

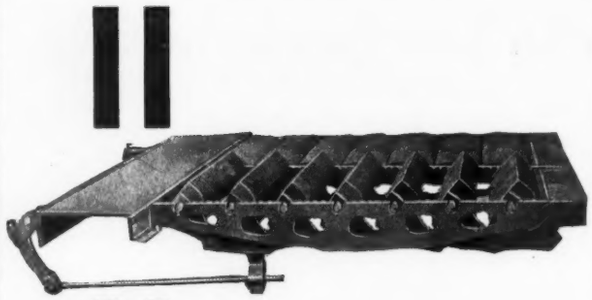
The Vogt

The Water-Tube Boiler For Long Service

THE very rapid circulation of the water through the *three* banks of tubes peculiar to all Vogt Water Tube Boilers reduces the formation of scale in the tubes to a minimum. This feature with the free expansion and contraction of the tubes, assures a life of unusual duration.

Investigate for yourself—we are glad to send catalog.

Henry Vogt Machine Co., Inc., Louisville, Ky.



No weak spots in Cyclone Grates

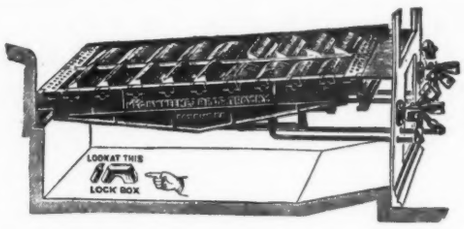
They are so constructed that warping and buckling are a practical impossibility. And—there are no points or fingers to burn off.

Cyclone Grates lighten labor for ash will not stick in them and they clean the fire evenly and well. If you would increase the efficiency of your boilers, send for our catalog.

Cyclone Grate Bar Co.

(Main Office) Buffalo, N. Y.

New England Agent: R. F. Morse, 74 Weybosset Street, Providence, R. I. Western Agent: M. R. Detrick, 549 West Washington Street, Chicago, Ill.



Neemes Grates Save all Ways

First of all, the saving is in the quality of the coal you burn. Use any cheap grade and you'll get high efficiency when you burn it on a Neemes Bros. Improved Shaking and Dumping Grate.

The next saving is in firemens' time—no special attention is necessary.

Then there's the triple value feature; you can shake out the ashes, cut out the clinkers, and, when desired, dump the fire.

Get details from the "Neemes Book"—Write.

NEEMES BROTHERS

41-49 Adams Street, Troy, New York

Manufacturers of Round and Square Grates.

Babcock & Wilcox, Ltd., Montreal, Canada, Sole Makers for Canada. Burke Engineering Co., 525 Industrial Building, Providence, R. I., Sole Agents for the New England States. C. F. Catillaz, 30 Church St., New York. Jeffery-Griner Machinery Co., Bourse Bldg., Philadelphia, Penn.

Murphy Automatic Furnace

Write for record of Murphy Furnace Economies and get Catalog "E" today.

ANY man who can fire a boiler and obtain as high an efficiency as the Murphy is worth more money to you in some other department.

MURPHY IRON WORKS Detroit Mich. U. S. A.

208

Maximum Furnace Efficiency in Your Boiler

You can realize the efficiency of the best mechanical stoker under your own boilers by hand firing—if you equip them with

The National Smokeless Stoker-Grate

Nearly smokeless combustion guaranteed with the cheapest grades of fuel. Less work for the firemen and a big saving in operating cost. Low in price. Write.

New Albany Manufacturing Co. **New Albany, Indiana**

HAMMEL OIL BURNERS

Over 7500

In Use Under Stationary Boilers, Locomotives, Kilns, Etc.

Write for Circular of Hammel Patent Furnace for Water-Tube Boilers

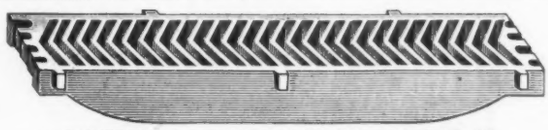
HAMMEL OIL BURNER CO.,

Los Angeles, Cal.

The Martin Rocking Grate

is the **only ADJUSTABLE** one made—handles lump or finest screenings. Send for booklet.

Martin Grate Co., 341 So. Dearborn St., Chicago



STATIONARY
DUMPING
SHAKING

GRATE BARS

SALAMANDER GRATE BAR CO., 126 Liberty St., New York

This 4 in 1 Grate—

Ash sifter—vibrating, shaking and dumping grate—combining all their good points, reduces fuel bills 10 to 40%.

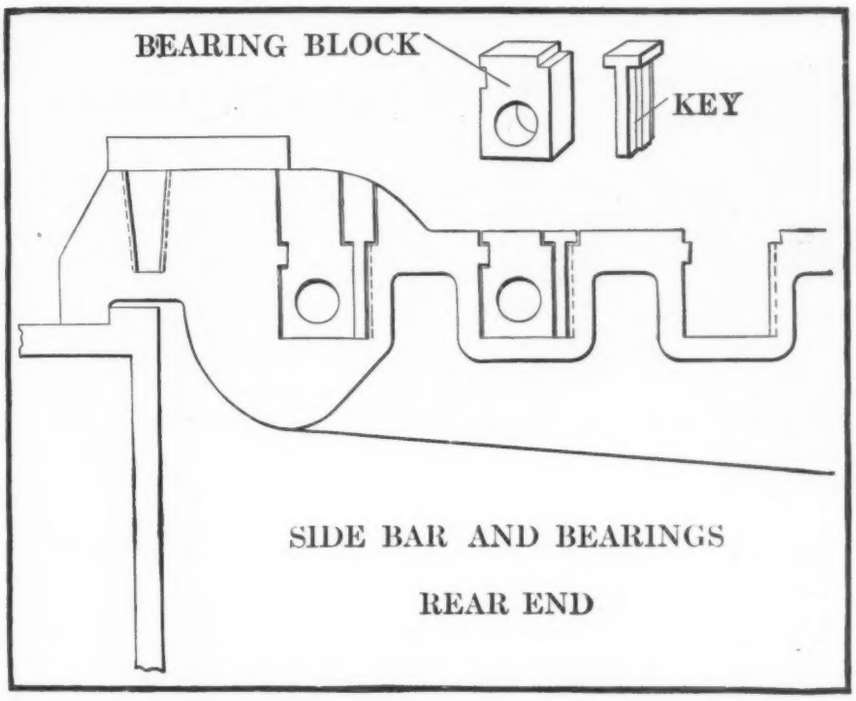
We show you where and how. Write us.

The Armstrong Mfg. Co., Springfield, Ohio

WATER SOFTENING OR FILTRATION

FOR BOILER FEED AND ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.



These Grate Bars Can't Lift Out!

Just note the features of the bearing blocks in the side bars of this grate, and the way they are held in place. The grate bars *can't* lift out and dump coal into the ash pit. Furthermore, bearing blocks and keys are so carefully fitted that the frequent trouble with other grates in erection is eliminated. This design of bearing also allows ready replacement of a worn or broken bearing without needing to renew whole side bar.

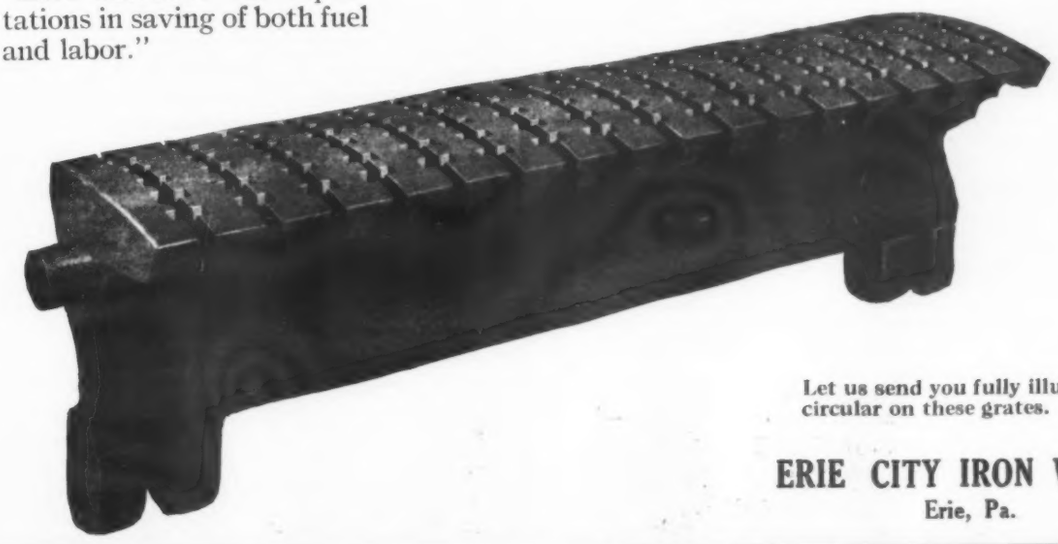
This is but one feature which commends the

ERIE CITY SHAKING GRATE

to users who are studying low maintenance, fuel and labor economy.

A specially designed side bar prevents side bars dropping down. The air space is *proper* size for the average coal, and bars are designed so they prevent loss of coal when grates are shaken.

"Erie City Shaking Grates we purchased through your office," says one user under date of Oct. 10th, "have exceeded our expectations in saving of both fuel and labor."

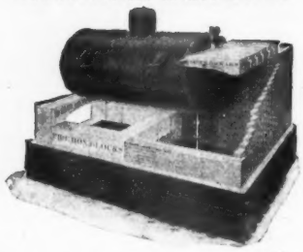


Let us send you fully illustrated circular on these grates. Write.

ERIE CITY IRON WORKS
Erie, Pa.

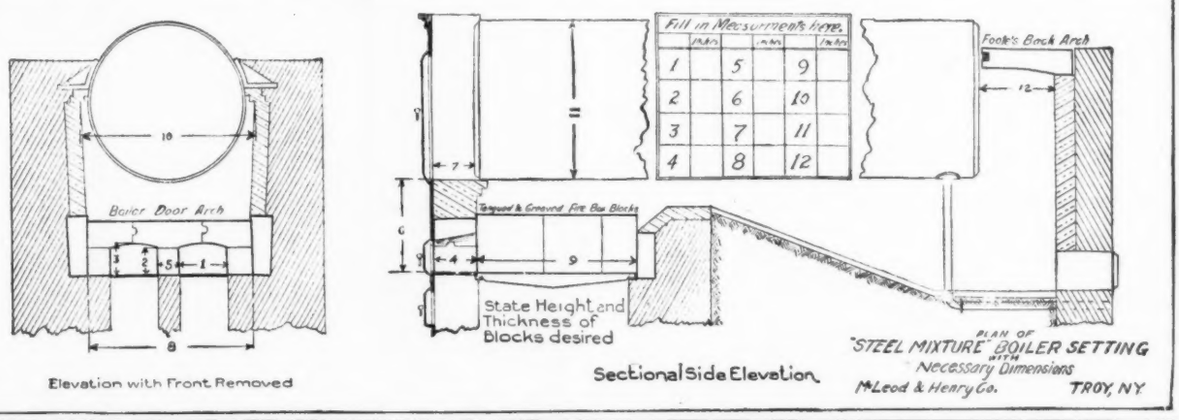
Here Are The "STEEL MIXTURE" Measurements

Send them in and get a price for an outfit for your boiler.



Boiler door arches, fire box blocks, and back arches can be shipped on receipt of order.

Boston Office, 141 Milk St. **McLeod & Henry Co., Troy, N. Y.** **New York Office, 1402 Broadway**


Fill in Measurements here.
Boiler Door Arch
Elevation with Front Removed
Tongued & Grooved Fire Box Blocks
State Height and Thickness of Blocks desired
Sectional Side Elevation
Foote's Back Arch
"STEEL MIXTURE" PLAN OF BOILER SETTING WITH Necessary Dimensions
McLeod & Henry Co. TROY, NY

WIEDERHOLDT CHIMNEYS

(PATENTED)

Built to outlast any part of your plant from the most enduring building materials known. Highly resistive to all gases, acids, and the elements.

There's one near you. Send for list of users and Catalogue. "The Modern Chimney."

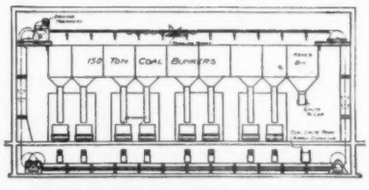
WIEDERHOLDT CONSTRUCTION CO.
Commonwealth Trust Building, ST. LOUIS, MO.

Boiler House Equipment

For Handling
Coal *and* Ashes

Simple in Design **Efficient in Operation** **Low Initial Cost**

Let us show how to modernize your Methods—and Results obtained by Handling Fuel mechanically. Send for "Equipment" Catalog.



GIFFORD-WOOD CO.
BOSTON **HUDSON, N. Y.** **CHICAGO**

The MODERN WAY of handling ASHES is by the

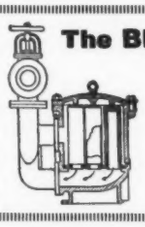
GECO PATENTED APPLIANCES

PNEUMATIC SYSTEM

Write and let us tell you all about it.

GREEN ENGINEERING CO.
Steger Building **Chicago, Ill.**

Catalogue 8—GECO Pneumatic Ash Handling Systems.
Catalogue "H"—Green Chain Grate Stokers.



The BLACKBURN-SMITH Feed Water Filter and Grease Extractor

removes oil and other suspended impurities from feed water by means of double filtration through layers of terry cloth. No other filter is so easy to clean and so thorough in action. Write for free book on *"Feed Water Filtration."*

JAMES BEGGS & CO., 40 Warren St., New York

You'll Get the Right Draft

and burn the cheapest coal if your boilers are equipped with

NEW MODEL TURBO-BLOWERS

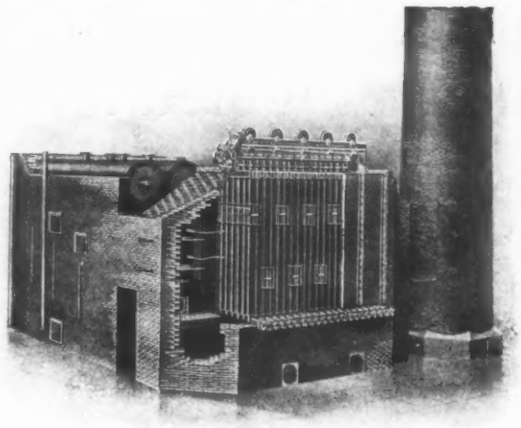
They stop fuel waste and increase the steaming capacity of every boiler. **Write.**

Turbo-Blower Co., 30 Church St. New York

Also Standard Damper Regulators

High Grade Fire Clay Brick for Boiler Settings

Plants in Pennsylvania, Ohio, Indiana, Kentucky and Alabama
Harbison-Walker Refractories Co., Pittsburgh, Pa.



Green's Fuel Economizer in Operation.

Green's Fuel Economizer

1. Utilizes waste heat, thereby saving 10-25% of fuel.
2. Increases steaming capacity of boilers.
3. Provides large quantities of water at all times for all purposes.
4. Prolongs life of boilers.

If you will write and give us the conditions prevailing in your plant we will tell you what we could do for you.

The Green Fuel Economizer Co.
90 West Street, New York City
and all Principal Cities.

Stop Dosing Your Boilers with Compounds

A boiler or heater that needs perpetual dosing is **sick** and does sick work. It is cheaper to prevent scale and pitting diseases by removing the **cause.** Install a

BARTLETT-GRAVER
Water Softener & Purifier

It softens and purifies the water, at a cost of only 1c. to 2c. per 1000 gallons. **Send for our Blue Book.**

WM. GRAVER TANK WORKS
East Chicago Indiana

DIXON'S BELT DRESSINGS

Add to the power and durability of any belt.
Send for "The Proper Care of Belts," No. 94.
Made in JERSEY CITY, N. J., by the
Joseph Dixon Crucible Company

STEAM ECONOMY TURBINE

'ECONOMY' Steam Turbines

for driving Generators, Pumps, Blowers and for Belt Drive.
See our page advertisement in last or next issue.

Kerr Turbine Company, Wellsville, N. Y.
Representatives in all large cities

JUST FACTS

There is no theory in the Power Plant Libr -y—only facts. Facts about things in the engine room as you see them, as they are.

If you want the facts about boilers, engines, dynamos, turbines, piping, pumps, shafting, refrigerating machinery, the Power Plant Library will supply them.

The Power Plant Library is not only the most used library among engineers, oilers and firemen, but owing to its principles applying directly to actual performances it is now employed as a work of reference by thousands of draftsmen, machinists and mechanics in general.

Can we send your set today? In consideration of the fact that this is the most used library for engineers, it is a duty to yourself to at least examine the books and see what they contain.

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Just return the coupon.

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Res. Address.....
City and State.....
Where employed .....
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Made It Hot for His Neighbors. Now He Is a Popular Engineer.

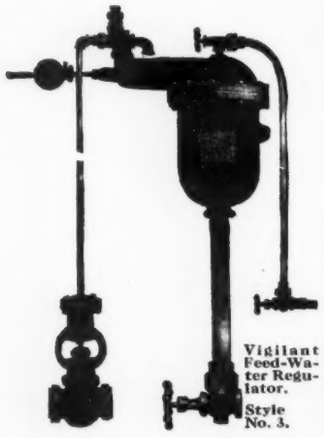
This hotel was burning up its profits in huge furnaces in a fruitless effort to keep the guests warm. The power plant nearby was wasting its exhaust steam. A live-wire engineer took advantage of the situation to prove his competency. He got in touch with us. We gave him a plan whereby he proved the wasted exhaust steam could be sold to the hotel at a price far lower than heating was then costing it. The hotel bought the heat and now get this—the sale yielded a profit that paid the year's coal bill for the power plant.

Of course, the engineer got the job as head of the power plant. He was out a job when the plan to make the hotel hot suggested itself.

Don't let anyone beat you to it. If there are buildings in your neighborhood, write to us now and we'll help you sell them heat. This is the season to plan for the sale of heat and they say coal will be higher.

Write today.

American District Steam Co., General Offices and Works: **North Tonawanda, N. Y.**
CHICAGO, First Nat. Bk. Bldg. **SEATTLE, Hoge Bldg.**



Vigilant Feed-Water Regulator. Style No. 3.

VIGILANT FEED WATER REGULATOR

Perhaps that waste is in your boiler room—

More money can be wasted in the boiler room of a power plant than can be saved in an engine room in six months.

By keeping the water-level uniform the Vigilant effects a great economy in fuel. This is because the regulator maintains the water always at the point of maximum heating surface and maximum steam space. Prove it by our free trial.

Write now for our catalog and we'll send it along free with a set of engineer's data cards that you'll find of increasing value daily.

The Chaplin-Fulton Mfg. Company, 58 Penn Avenue, Pittsburgh, Pa.
Also Manufacturers of The Fulton Pump Governor

Permutit

The Water Softener To Zero Hardness

By the Permutit Filter Process all scale-forming salts are removed from your boiler feed water before it enters your boilers. Changes in hardness of water are automatically taken care of. Result, absolute elimination of boiler scale. Write for full details.

THE PERMUTIT COMPANY
30 E. 42nd St., New York

IMPORTANT TO YOU

Reduce operating expenses; eliminate delays; obtain efficient service by installing

SPRAGUE HOISTS

They meet all requirements, which are conducive to a successfully-managed plant.

½ Ton to 6 Tons—A. C. or D. C.

Write for Descriptive Pamphlet No. 9052.

Sprague Electric Works
OF GENERAL ELECTRIC CO.
Main Office, 527-31 W. 34th St., New York, N. Y.
Branch Offices in Principal Cities.

Why Waterproof Belting?

Simply because moisture carried in air has a bad effect on belting that is not waterproof.
Moisture rots fibre when unprotected.
Moisture affects the length and strength of belting unless it is thoroughly waterproof.
And here comes the greatest and best reason why you should buy Duxbak Waterproof Leather Belting.— ¶The Duxbak process that makes this belting waterproof improves leather greatly, saves power and repairs.

Send for a small belt as a "starter."

Chas. A. Schieren Company

Established 1868.

DUXBAK BELTING
TRADE MARK
Reg. U.S. Pat. Off.

Tanners, Belt Manufacturers, 69 Cliff St., New York

Boston, 641 and 643 Atlantic Ave., opp. South Station. Philadelphia, 226 N. Third St. Denver, 1752 Arapahoe St. Pittsburgh, 205 Wood St. Chicago, 128 W. Kinzie St. Seattle, Wash., 620 Fourth Ave. Petersburg, Va., 122 Shore St. Henry Simon, Ltd., 20 Mount St., Manchester, England—Sole Agents for the United Kingdom. OAK LEATHER TANNERIES, Bristol, Tenn.

Keep Your Belts "Alive"

To a dry, parched, squeaking belt a little *Signet Belt Dressing* is like water to a horse.

It revives the leather, works down into the burning hide and softens it.

The belt "wakes up," becomes flexible and as pliable as new.

We manufacture also LePage's Belt Cement, which repairs belts as effectively as hooks, rivets or lace. Send for sample can of either.

Russia Cement Co.
Gloucester, Mass.

15 Years Building DIESEL Engines
Send for Bulletins

DIESEL ENGINES

Our Engines Operating in 26 States
Watch for our full page ads

BUSCH-SULZER BROS.-DIESEL ENGINE COMPANY

St. Louis — Minneapolis, 754 Plymouth Bldg. Houston, 703 Carter Bldg. — San Francisco, 423 Rialto Bldg. Los Angeles, 600 San Fernando Bldg. — U. S. A.

Enough power is saved by "American" pulleys to make them necessary—Why? Because THEY DO NOT FAN air but CUT it. Call at one of our stores and see it proved or write us.

The American Pulley Co. Philadelphia Boston New York Chicago

"SPARTAN" BELTING—
Better Service—Lasts Longer

Given the same conditions, "SPARTAN" will give you *better* service and last *longer* than any other belting made. It is heat, oil, water, steam and friction proof. We *guarantee* each roll of "Spartan" to be that.

A handy little booklet "The Care of Belting" No. 17-S will be be mailed free to you if you'll write.

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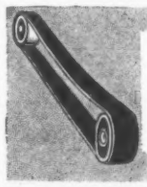

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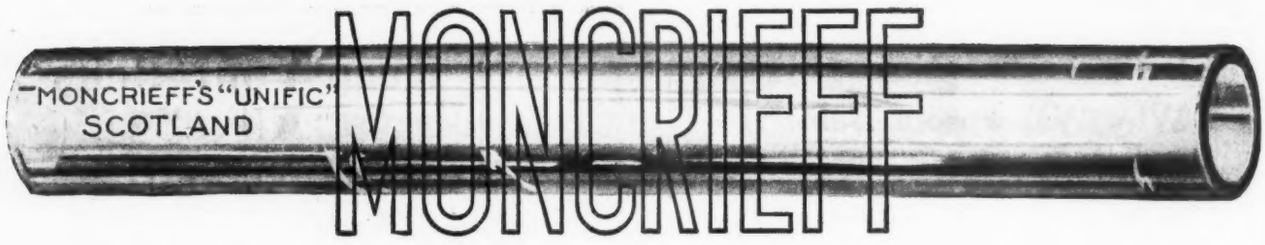

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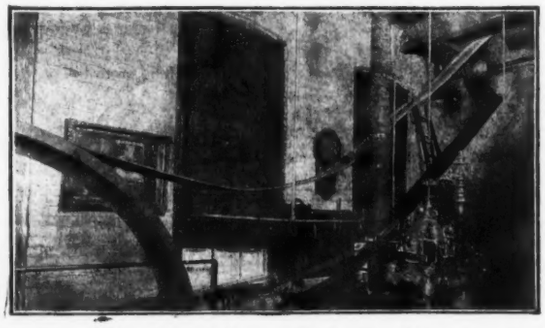

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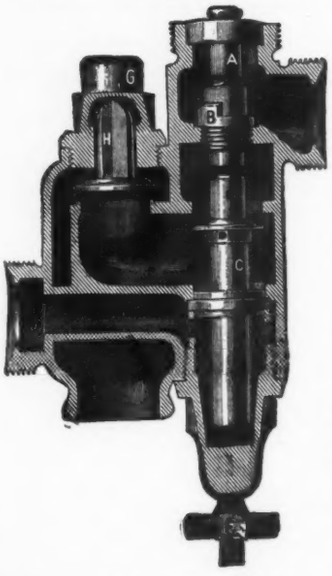

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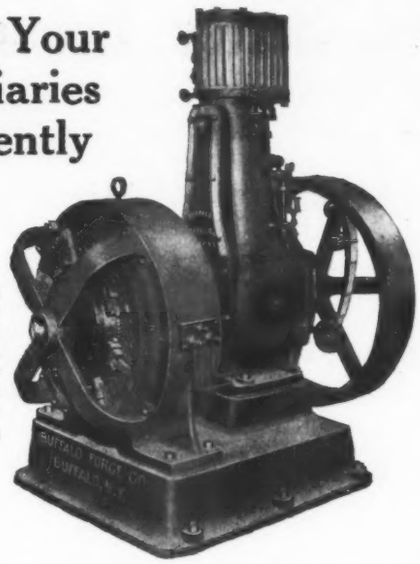

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It measures all the steam, air or gas all of the time.

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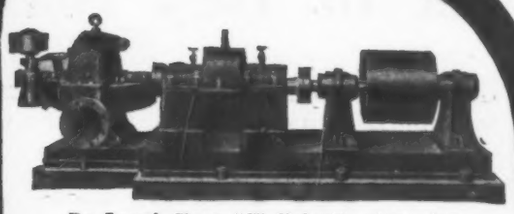

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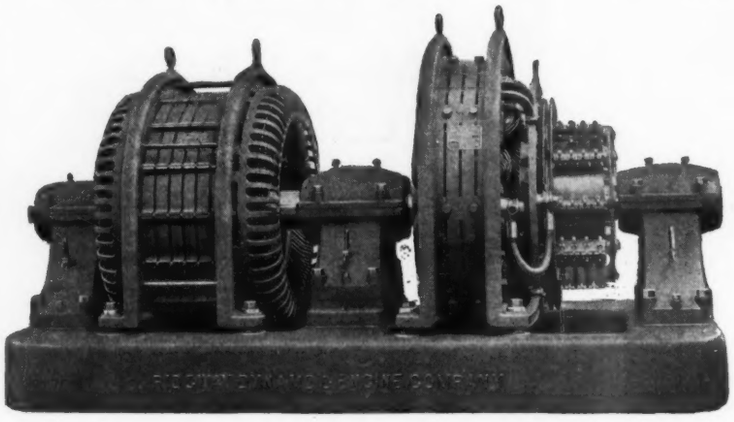

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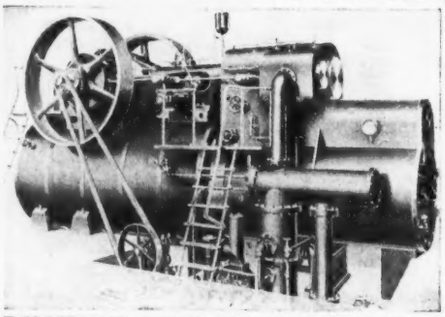

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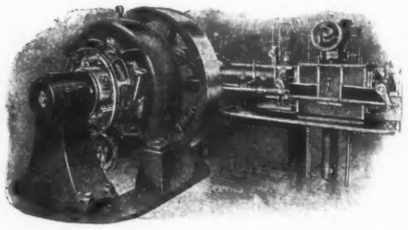

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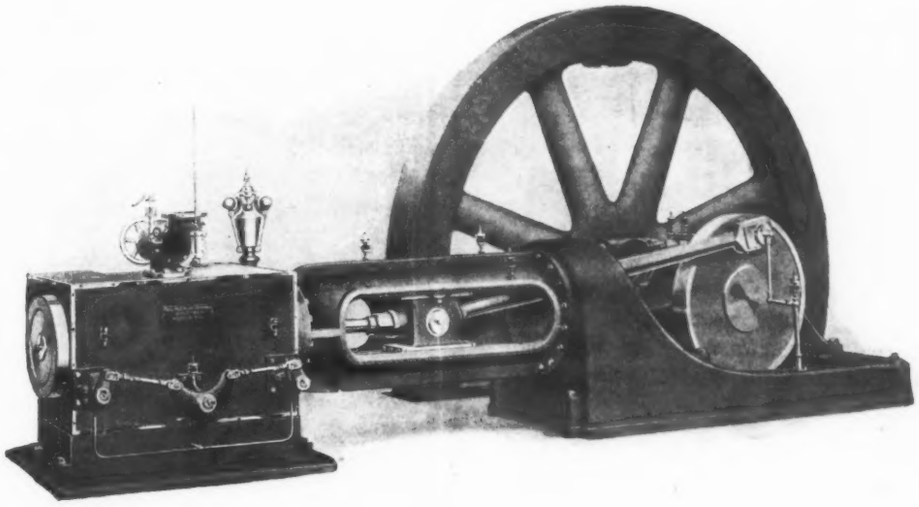
ROLLINS



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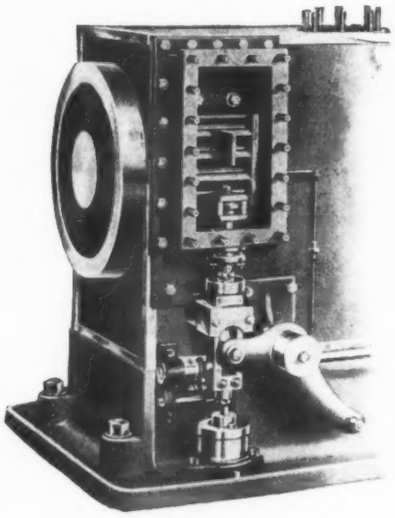

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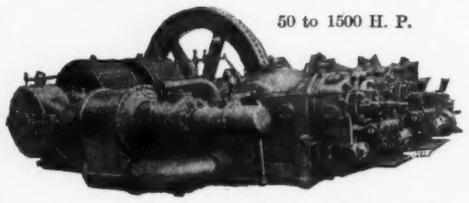

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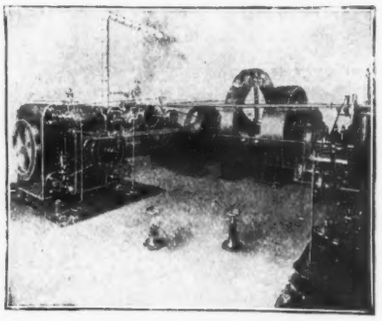

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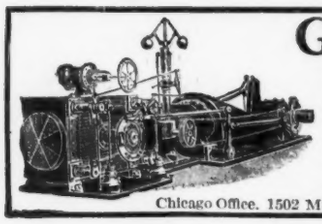

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